Ontario

Apprenticeship
In-school Curriculum Standards

Truck and Coach Technician

Level 3

310T

Ministry of Training, Colleges and Universities

Apprenticeship
In-school Curriculum Standards

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Implementation date: September 2010
Printing date: February 2011

ISBN 978-1-4435-5734-4 (Print)
ISBN 978-1-4435-5735-1 (PDF)

Printed on recycled paper

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10-351

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Introduction

The Truck and Coach curriculum (T&C) level 3 has been developed in keeping with the prescribed Ministry of Training, Colleges and Universities (MTCU) Training Standards, which apply to the Truck and Coach Technician apprenticeship. The curriculum layout used provides an opportunity to cross-reference the in-school learning outcomes and content to the specific workplace Training Standards.

For easy reference, a time allocation has been included for each reportable subject, along with the Theory/Practical breakdown for the delivery of the Learning Content. More detailed time allocations for the instructor have been provided for each topic area to assure consistency for each apprentice intake.

The continual introduction of innovative techniques and more complex equipment is resulting in increasing demands for tradespersons who are not only skilled in the practical aspects of the trade, but who also have a sound theoretical knowledge of the inspecting, diagnosing, repair, and servicing requirements. The curriculum has been developed to provide this theoretical knowledge and to offer some practical applications to complement the on-the-job work experiences of the Truck and Coach apprentice.

The objective of the curriculum, therefore, is to provide a basis for:

a. Sound theoretical training that meet the challenges presented by the increasingly more complex equipment designs and testing techniques.
b. A reinforcement of fundamental skills of the trade through the exposure to practical applications.
c. Developing in the apprentices high standards of craftsmanship, problem-solving skills, and personal pride in their trade.
d. Developing desirable work attitudes and a keen sense of responsibility, particularly concerning public and personal safety.

The curriculum has been designed to give the instructor every reasonable opportunity for flexibility and innovation without deviating to any significant degree from the subject requirements, as determined by the Industry Committees and as prescribed in the Regulations for the Trades. Since the scope of the prescribed curriculum is quite extensive, the apprentices must be expected to reinforce the acquired knowledge through regular independent out-of-classroom assignments. The curriculum has been presented in a chronological sequence in keeping with sound teaching methodologies. However, the actual application of the sequence may differ somewhat between colleges because of scheduling, staffing, and facilities utilization.

The curriculum includes specific references to the Ministry of Training, Colleges and Universities Apprenticeship Training Standards. While these references to various performance objectives in the Training Standards have been linked to the respective in-school outcomes, employers should not assume complete coverage to a journeyperson level. The in-school delivery focuses primarily on the knowledge required to master the respective objectives outlined in the Training Standards. Employers, therefore, are expected to complete the training of these respective objectives by applying the prescribed in-school knowledge to the required practical learning experienced in the work setting.

To ensure that apprentices will be able to successfully demonstrate the learning outcomes according to performance criteria, specific times have been allocated in the respective areas to allow for some applications enhancement. It is of utmost importance that all application assignments relate to prescribed experiences only. Time constraints will not permit engaging apprentices in tasks of limited learning benefit that are unrelated to the curriculum outcomes. In the Learning Content section, whenever an assigned operation for an applied test or repair procedure indicates that a demonstration should be performed, there is only enough time allocated for the instructor to perform the activity.

Regular evaluations of the apprentices' learning achievements must be performed in both theory and practical applications throughout the program to ensure consistency with learning outcome expectations. Testing of apprentice knowledge and skills will take place during the allotted delivery hours for each unit. In addition to providing an evaluation of apprentice competency, the review of test question answers is considered to be a valuable learning opportunity.

In all practical activities, the apprentices will observe the Occupational Health and Safety Act and the applicable regulations including use of personal protective equipment. Institutional regulations and policies may also apply.

Participation by Stakeholders

A consortium of six colleges of applied arts and technology, working in collaboration with the Ministry of Training, Colleges and Universities and industry stakeholders, participated in the development of this document. The development and subsequent revisions were based on the training standards that were previously revised by the MTCU in consultation with industry advisory groups. The development was completed using a process and format approved by MTCU.

Participating Colleges

- Cambrian College of Applied Arts and Technology (Project Lead)
- Algonquin College of Applied Arts and Technology
- Centennial College of Applied Arts and Technology (T&C Lead)
- Fanshawe College of Applied Arts and Technology
- Mohawk College of Applied Arts and Technology
- Sault College of Applied Arts and Technology

Industry Representatives:

Equipment World Ltd
Sudbury Truck & Trailer Ltd
Toromont CAT Ltd
Nortrax Ltd
Xstrata Nickel Ltd
Atlas Copco Construction & Mining Canada Ltd
Elmira Farm Service Ltd
Liftow Inc.
Vale Inco Ltd
Volvo Canada Ltd
McGavin Farm Equipment Ltd.

The first step in the development process was to assemble a Project Steering Committee (PSC), consisting of both industry representatives and apprenticeship in-school deliverers. The PSC initiated the plan for the project development that followed. The PSC established six working teams, each responsible for the development of in-school apprenticeship curriculum documents for the specific motive power trades listed below:

- Level 1 common to Agricultural Equipment, Heavy Duty Equipment, Powered Lift Truck, and Truck and Coach
- Level 2 common to Agricultural Equipment and Heavy Duty Equipment
- Level 3 specific to Agricultural Equipment
- Level 3 specific to Heavy Duty Equipment
- Level 2 and 3 specific to Powered Lift Truck
- Level 2 and 3 specific to Truck and Coach

The six teams worked with advisory groups during the development of the curriculum. The advisory groups were industry representatives who ensured content validity. During various stages of the process, the PSC and participating industry advisory groups evaluated the draft curriculum documents and provided feedback and recommendations for revisions.

Truck & Coach Technician

Level 3

Program Summary of Reportable Subjects – Level 3

Reportable Subjects	Total	Theory	Practical
S1292.0 Trade Practices and Auxiliary Systems	24	14	10
S1293.0 Engine Systems	40	24	16
S1294.0 Electricity and Electronics	32	17	15
S1295.0 Fuel Systems	24	18	6
S1296.0 Vehicle electronic Management and Emission Systems	32	21	11
S1297.0 Drive Trains	40	22	18
S1298.0 Steering, Suspension and Brake Systems	48	25	23
Total	**240**	**144**	**96**

Number: S1292

Reportable Subject: **Trade Practice and Auxiliary Systems**

Duration: Total 24 hours Theory 14 hours Practical 10 hours

Prerequisites: T.C. Level 2

Co-requisites: None

1.1 Truck and Coach Heating and Ventilation Air Conditioning

22 Total Hours Theory: 12 hours Practical: 10 hours

1.2 Regulatory Requirements

2 Total Hours Theory: 2 hours Practical: 0 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
70%	30%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Trucks or buses equipped with functional AC systems	Specialized safety equipment
Reefer equipped with functional climate control	Access to CVSA and TMC regulations
Refrigerant recovery equipment	OEM data hub access
Ventilating equipment	Personal safety equipment
Refrigerant evacuation and recharging equipment	ESTs (Electronic Service Tools)

S1292.1 **Truck and Coach Heating and Ventilation Air Conditioning**

Duration: Total 22 hours Theory 12 hours Practical 10 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5139, 5151

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair truck and coach heating, ventilation and air conditioning systems to manufacturer and environmental safety standards.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

1.1.1 Explain the purpose and fundamentals of truck and coach HVAC theory.

[4/0]
- **thermodynamics**
- **heat transfer**
- **climate control systems**
- **temperature and relative humidity relationship**
- **change of state, latent and sensible heat**
- **properties of refrigerants**
- **gas laws, temperature, pressure and volume**
  - storage
  - purchasing
  - recovery
  - disposal
  - legal Issues
- **environmental effects of refrigerant**

1.1.2 Identify the functions, construction, composition, types, styles and application of truck and coach HVAC theory and reefer systems.

[4/0]
- **climate control systems**
- **reefer circuit components**
- **heating and ventilation**
- **electronic**
- **mechanical**
- **cycling clutch systems**
- **orifice tube**
- **expansion valve**
- **identify types of refrigerants**
  - OEM Recommended
  - alternate
- **lubricants**

- **system control devices**
  - zone control
  - data bus communication
- **flow control valves**
- **system protection devices**
  - APADS
  - low temperature / pressure
  - high temperature / pressure
- **expansion valves and orifice tubes**
- **clutch controls**
- **condensers**
- **receiver dryer**
- **accumulator-dryer**
- **evaporator**
- **heater cores compressors**
- **axial recirculating**
- **radial**
- **variable displacement**
  - hoses, lines and fittings
  - van insulation requirements

1.1.3 Describe the principle(s) of operation of truck and coach HVAC systems.

[4/0]
- **heating system operation**
- **AC system operation**
- **climate control**
  - temperature controls
  - airflow management
  - characteristics of refrigerants
- **characteristics of lubricants**
- **system protection devices**
  - low and high-pressure cutout
  - low charge protection
  - low pressure cycling control
- **compressor cycle**
  - cycling clutch
  - variable displacement
- **reefer system operation**
- **cryogenic systems**

1.1.4 Perform inspection, testing and diagnostic procedures on truck and coach HVAC systems.

[0/6]
- **identify the location of system components and controls**
- **performance test**
  - heating system
  - AC system
  - climate control
- **test for refrigerant and coolant leaks**
- **test system for operating pressure and control functions**
- **outline service requirements of various refrigerants**

1.1.5 Recommend reconditioning or repairs following manufacturers' procedures on truck and coach HVAC systems.

[0/4]
- **outline procedures required removing and replacing HVAC system components**
- **perform drive belt adjustments**
- **demonstrate recovery, recycling, evacuation**
- **recharging procedures**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing and skin protection
  - refrigerants
  - green house gas and ozone depletion potential
  - open flame contact precautions, handling, inhalation, skin and eye contact, system pressures and handling of refrigerant cylinders
  - prevention of leakage to the atmosphere
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1292.2 **Regulatory Requirements**

Duration: Total 2 hours Theory 2 hours Practical 0 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5135

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to describe the legal responsibilities of employers and employees for safety, environment and equipment practices according to Government Safety and Environmental Legislation.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

1.2.1 Explain the legal responsibilities as applied to Government Legislation for relevant workplace activities.

[2/0]

- **Highway Traffic Act**
  - CVOR (Commercial Vehicle Operator's Registration)
  - vehicle safety inspection
  - legal liability
- **Out of Service Criteria (OOS)**
- **Commercial Vehicle Safety Alliance (CVSA)**
- **Federal Motor Vehicle Safety Standards (FMVSS)**
- **Canadian Motor Vehicle Safety Act (MVSA)**
  - technical standard documents
- **American Trucking Association**
  - recommended practices (R.P)
  - Technical and Maintenance Council (TMC)
- **Society of Automotive Engineers (SAE)**
  - J-standards
- **consumer protection legislation**

GENERAL PRACTICES

- **safety precautions**
  - interpretation of regulatory information
  - data base of government and industry resources
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention Systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: S1293

Reportable Subject: **Engine Systems**

Duration: Total 40 hours Theory 24 hours Practical 16 hours

Prerequisites: T.C. Level 2

Co-requisites: None

2.1 Heavy Duty Intake Systems

4 Total Hours Theory: 2 hours Practical: 2 hours

2.2 Heavy Duty Exhaust Systems

4 Total Hours Theory: 2 hours Practical: 2 hours

2.3 Turbochargers and Roots Blowers

4 Total Hours Theory: 3 hours Practical: 1 hour

2.4 Advanced Heavy Duty Cooling Systems and Coolants

4 Total Hours Theory: 3 hours Practical: 1 hour

2.5 Heavy Duty Lubricating Systems and Oils

4 Total Hours Theory: 3 hours Practical: 1 hour

2.6 Diesel Engine Brakes and Retarders

3 Total Hours Theory: 2 hours Practical: 1 hour

2.7 Diesel Engine Component Failure Analysis

6 Total Hours Theory: 4 hours Practical: 2 hours

2.8 Diesel Engine Diagnostic Procedure and Practices

8 Total Hours Theory: 5 hours Practical: 3 hours

2.9 Diesel Engine Run-in and Testing

3 Total Hours Theory: 1 hour Practical: 2 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
60%	40%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Functional electronically managed diesel engines	Precision measuring tools
Full range of disassembled engine components	Chassis or engine dynamometer
Assortment of failed engine components for failure analysis	OEM diagnostic software
Ventilating equipment	OEM data access including online service information systems (SIS)
Specialty engine tools	(EST's) Electronic Service Tools and CAs

1293.1 Heavy Duty Intake Systems

Duration: Total 4 hours Theory 2 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5139, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair heavy duty, diesel engine intake systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.1.1 Explain the purpose and fundamentals of heavy-duty intake systems.

[0.5/0]
- **diesel engine theory**
- **thermodynamics**
- **volumetric efficiency**
- **air charge temperature**
- **manifold boost**
- **heat exchanger**
- **positive filtration principle**

2.1.2 Identify the functions, construction, types, styles and application of heavy-duty intake systems.

[0.5/0]
- **pre-cleaners**
- **positive dry air cleaners**
- **intake manifold design**
- **valve configuration**
- **inlet restriction sensor**
- **mass airflow sensor**
- **change air coolers**
- **exhaust gas recirculation (EGR)**
- **venture / pressure differential**
- **intake manifold temperature sensor**
- **intake air heaters**

2.1.3 Describe the principle(s) of operation of heavy-duty intake systems.

[1/0]
- **positive principle dry air filters**
- **cyclonic precleaners**
- **volumetric efficiency**
- **lean burn technology**
- **engine breathing**
- **thermal efficiency**
- **gas dynamics**
- **intake Air Heaters**

2.1.4 Perform inspection, testing and diagnostic procedures on diesel intake systems.

[0/1]
- **air induction inlet restriction test**
- **outline methods of tracing boost side and charge air cooler leakage**
- **analyze filter element conditions**
- **outline requirements for servicing air filters**
- **charge air cooler restrictions / leaks**

2.1.5 Recommend reconditioning or repairs following manufacturers' procedures on diesel intake systems.

[0/1]
- **verify the readings of an in-dash, inlet restriction gauge with a water manometer**
- **outline method of locating manifold boost leakage**
- **outline method of replacing charge air coolers**
- **outline OEM method for determining air filter serviceability**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and skin protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
- **communication**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1293.2 Heavy Duty Exhaust Systems

Duration: Total 4 hours Theory 2 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair heavy duty, diesel engine exhaust systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.2.1 Explain the purpose and fundamentals of heavy duty exhaust systems.

[0.5/0]
- **engine theory**
- **thermodynamics**
- **volumetric efficiency**
- **air change temperature**
- **manifold boost**
- **heat exchanger**
- **air charge density**
- **exhaust backpressure factors**

2.2.2 Identify the functions, construction, composition, types, styles and application of heavy duty exhaust systems.

[0.5/0]
- **exhaust manifold**
- **exhaust piping**
- **pyrometers**
- **engine silencers**
- **catalytic converters**
- **exhaust stacks**
- **rain caps**
- **particulate traps**
- **diesel particulate filters**
- **aqueous urea**
- **dosing injectors**

2.2.3 Describe the principle(s) of operation of heavy duty exhaust systems.

[0.5/0]
- **exhaust gas dynamics**
- **sound analysis energy and noise suppression**
  - sound absorption principles
  - resonator principles
- **particulate traps**
- **diesel particulate filters**
- **oxidation catalytic converters**
- **exhaust gas chemical characteristics**
- **dosing requirements of reduction catalysts**

2.2.4 Perform inspection, testing and diagnostic procedures on diesel engine exhaust systems.

[0.5/1]
- **test exhaust gas backpressure**
- **outline procedure for analyzing exhaust gas chemistry**
- **demonstrate opacity meter smoke analysis**

2.2.5 Recommend reconditioning or repairs following manufacturers' procedures on diesel engine exhaust systems.

[0/1]
- **outline procedure for replacing engine silencers**
- **outline procedure for replacing exhaust piping**
- **outline procedure for replacing a pyrometer**
- **outline procedure for replacing a catalytic converter**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and skin protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
  - potential lifting hazards
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1293.3 Turbocharging

Duration: Total 4 hours Theory 3 hours Practical 1 hour

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5139, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair turbochargers.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.3.1 Explain the purpose and fundamentals of turbocharging.

[1/0]
- **turbine theory**
- **thermodynamics**
- **volumetric efficiency**
- **air charge temperature**
- **manifold boost**
- **heat exchanger**
- **air charge density**

2.3.2 Identify the functions, construction, composition, types, styles and application of turbocharging.

[1/0]
- **pulse air manifolds**
- **turbine housing**
  - divided chamber
  - ceramic turbine wheels
  - high alloy steel turbine wheels
  - volute
- **constant geometry**
- **variable geometry**
  - waste gate
  - variable volute
  - variable nozzle
  - methods of control
- **compressor housing**
  - impellers
  - volute
- **compounding**
  - viscous coupling
  - gear train
- **series turbocharging**

  - primary
  - secondary
- **parallel turbocharging**
- **exhaust pressure governor (EPG)**
- **discharge recirculation valve**

2.3.3 Describe the principle(s) of operation of turbochargers.

[1/0]
- **tuned exhaust manifolds**
- **pulse exhaust manifolds**
- **4-stroke cycle boost requirements**
- **turbine theory**
- **hydrodynamic suspension**
- **turbocharger lubrication and cooling**
- **constant geometry turbocharger principles**
- **variable geometry turbocharger principles**
  - compound
  - series
- **turbocharger efficiency and torque rise**

2.3.4 Perform inspection, testing and diagnostic procedures on turbochargers.

[0/0.5]
- **test manifold boost pressure**
- **test manifold boost temperature**
- **check for manifold boost leaks**
- **measure exhaust gas temperature**
- **visually inspect a turbocharger**
- **test axial and radial run-out**
- **verify wastegate operation**

2.3.5 Recommend reconditioning or repairs following manufacturers' procedures on turbochargers.

[0/0.5]
- **outline procedure for replacing a turbocharger**
- **outline procedure for replacing a boost sensor**
- **outline procedure for recoring a turbocharger**
- **outline procedure for reconditioning and balancing a turbocharger**
- **outline procedure for replacing a defective wastegate assembly**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and skin protection
  - rotating components
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1293.4 Advanced Heavy Duty Cooling Systems and Coolants

Duration: Total 4 hours Theory 3 hours Practical 1 hour

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5139, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair heavy duty cooling systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.4.1 Explain the purpose and fundamentals of heavy duty cooling systems and components.

[1/0]
- **thermodynamics**
- **heat rejection and transfer**

2.4.2 Identify the functions, construction, composition, types, styles and application of heavy duty cooling systems and coolants.

[1/0]
- **heavy-duty radiators**
  - down flow
  - cross flow
  - up flow
  - double pass
- **expansion tanks**
  - conventional
  - multi chamber
- **controlled fans**
  - variable pitch
  - thermatic
  - electronic
- **heat exchangers**
- **air to air**
- **intercooler**
- **tip turbine**
- **coolants**
  - properties coolant mixture characteristics
  - EG (ethylene glycol)
  - PG (propylene glycol)
  - ELC (extended life coolant)
- **coolant filters**
- **coolant pumps**
  - high capacity coach engine coolant pumps

  - centrifugal
- **thermostats**
- **actively pressurized cooling systems**
- **coolant temperature sensor**
- **radiator coolant level switches**
- **EPA requirements**

2.4.3 Describe the principle(s) of operation of heavy duty cooling systems and coolants.

[1/0]
- **heavy-duty radiators**
  - down flow
  - cross flow
  - up flow
  - double pass
- **controlled fans**
- **fan drives**
- **fan clutches**
- **coach oil driven fan hubs**
- **heat exchangers**
  - air to air
  - intercooler
- **actively pressurized cooling systems**
- **coolant properties**
  - coolant mixture characteristics
  - coefficient of heat transfer
- **coolant filters**
- **chemical balance**
- **analysis coolant**
- **analysis SCAs**
- **coolant pumps**
- **thermostat**
- **liner cavitation**
- **properties of coolants**
- **properties of water**
- **properties of anti-freeze**
- **coolant mixture characteristics**
- **coefficient f heat transfer**
- **analyzing coolants**
- **cooling system electrolysis**
- **chemistry of:**
  - EG
  - PG
  - ELC
- **coolant test instruments**
  - refractometer
  - hydrometer
  - pH analysis
  - electrical conductivity
- **chemical balance**

2.4.4 Perform inspection, testing and diagnostic procedures on diesel engine cooling systems and coolants.

[0/0.5]
- **heat exchangers and cooler performance efficiency**
- **temperature controlled fans operating cycles**
- **perform coolant and SCA analysis**
- **test operations of thermostat**
- **pressure test radiator**
- **perform visual and pressure tests on hoses**
- **radiator cap testing**
- **coolant analysis**
  - pH levels of coolant
  - coolant strengths and condition
  - test coolant SCA level
  - test coolant TDS level
- **outline procedure for mixing anti-freeze and water to engine cooling requirements**
- **outline procedure for adding premix**
- **outline procedure for ELC recharge**

2.4.5 Recommend reconditioning or repairs following manufacturers' procedures on diesel engine cooling systems.

[0/0.5]
- **diagnose coolant related overheating**
- **coolant filters**
  - service and service intervals
- **flushing cooling systems procedure**
  - oil contamination
- **coolant**
  - additive packages
- **service intervals**
- **cooling system failure analysis**
- **liner cavitation failure**
- **premix requirements**
- **refortifying ELCs**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - hazards of contact with coolant chemicals
  - hazards of coolant vapour inhalation
  - eye, hearing, breathing and skin protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1293.5 Heavy Duty Lubricating Systems and Oils

Duration: Total 4 hours Theory 3 hours Practical 1 hour

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5139

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to describe the operating principles of heavy duty lubricating systems and oils and repair typical lubricating circuit problems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.5.1 Explain the purpose and fundamentals of heavy duty lubricating systems.

[0.5/0]
- **diesel engine fundamentals**
- **heavy duty lubricating oils, synthetic oils**
- **significance of selecting correct lubricating oils for engine service**
- **service ratings**
- **Society of Automotive Engineers (SAE) viscosity ratings**
- **American Petroleum Institute (API) grades**

2.5.2 Identify the functions, construction, composition, types, styles and application of heavy duty lubricating systems.

[1/0]
- **significance of selecting correct lubricating oils for engine service**
- **service ratings**
- **Society of Automotive Engineers viscosity ratings**
- **American Petroleum Institute grades**
- **OEM requirements of engine lubricants**
- **lubricating circuits**
  - bypass valve
  - relief valve
- **filter types**
  - bypass
  - full flow
  - centrifugal
- **oil pumps**
- **heat exchangers**
  - bundle type
  - plate type
- **temperature management**
  - mechanical
  - electronic

2.5.3 Describe the principle(s) of operation of heavy duty lubricating systems.

[1.5/0]
- **lubricating circuits**
  - bypass valve
  - relief valve
- **filter types**
  - bypass
  - full flow
  - centrifugal
- **oil pumps**
- **heat exchangers**
  - oil cooler
  - bearings
  - hydrodynamic suspension
- **lubricant as coolant**
- **temperature management apparatus**

2.5.4 Perform inspection, testing and diagnostic procedures on diesel engine lubrication systems.

[0/0.5]
- **demonstrate bearing leakdown test**
- **demonstrate oil pressure tests**
- **demonstrate oil cooler test**
  - vacuum test bundle
  - pressure test bundle
- **oil condition**
  - contaminants

2.5.5 Recommend reconditioning or repairs following manufacturers' procedures on diesel engine lubrication systems.

[0/0.5]
- **oil analysis**
- **priming oil pump and lubrication circuit**
- **outline start-up and engine run-in procedure**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and skin protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1293.6 Diesel Engine Brakes and Retarders

Duration: Total 3 hours Theory 2 hours Practical 1 hour

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5139, 5140, 5141, 5152

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair diesel engine brakes and retarders.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.6.1 Explain the function, types and application of internal and external engine brakes.

[0.5/0]
- **retarder principles**
- **cylinder breathing**
- **vehicle braking dynamics**
- **power absorption equations**

2.6.2 Identify the principles of operation of internal and external engine brakes and hydraulic retarders.

[0.5/0]
- **internal compression brakes**
- **cycle management**
- **switching devices**
- **external compression brakes**
- **hydraulic retarders**

2.6.3 Describe, test, diagnose and adjust internal and external engine brakes.

[1/0]
- **mean effective pressure**
- **power absorption**
- **internal compression brakes**
- **exhaust choke brakes**
- **double cycle braking**
- **flywheel hydraulic retarders**

2.6.4 Perform internal and external engine brake removal, installation, and adjustments.

[0/1]
- **outline installation and removal procedure**
- **overhead adjustments**
- **programming brake cycles**
- **brake generated camshaft failures**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and skin protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1293.7 Diesel Engine Component Failure Analysis

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5139

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of failure analysis and implement them on failed diesel engine components.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.7.1 Explain the purpose and fundamentals of diesel engine component failure analysis.

[1/0]
- **engine theory**
- **thermodynamics**
- **lubrication circuits**
- **cooling systems**
- **temperature and stress related failures**

2.7.2 Identify the functions, construction, composition, types, styles and application of diesel engine component failure analysis.

[1/0]
- **catastrophic failures**
- **stress failures**
- **high temperature failures**
- **torsional failures**
- **compressional failures**
- **tensile failures**

2.7.3 Describe the principle(s) of operation of diesel engine component failure analysis.

[2/0]
- **catastrophic failures**
- **stress failures**
- **high temperature failure**
- **compressional failures**
- **tensile failures**
- **diagnosing operator related failures**
- **diagnosing technician related failures**
- **diagnosing manufacturing/material related failures**

2.7.4 Perform inspection, testing and diagnostic procedures on diesel engine failed components.

[0/1]
- **analyze major component failures**
- **outline procedure for determining cause of a catastrophic failure**
- **analyze sub-component failures**
- **match failed components to cause**
- **use OEM photography to determine sub-component serviceability**

2.7.5 Recommend reconditioning or repairs following manufacturers' procedures on diesel engine failed components.

[0/1]
- **determine serviceability of failed components**
- **review the criteria to determine whether components should ne reconditioned or replaced**
- **tracking of coincidental patterns**
- **analyses of OEM warranty practices**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and skin protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1293.8 Diesel Engine Diagnostic Procedure and Practices

Duration: Total 8 hours Theory 5 hours Practical 3 hours

Prerequisites: T.C. Level 2

TCT 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles and practices of sequential troubleshooting strategies and symptom based diagnostic routines on heavy duty diesel engines.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.8.1 Explain the purpose and fundamentals of diesel engine diagnostic procedure and practices.

[1/0]
- **engine theory**
- **electricity**
- **electronics**
- **computers**
- **sequential fault flow chart**
- **electronic schematics**
- **test instrumentation**
- **electronic service tools (EST)**

2.8.2 Identify the principle(s) of diesel engine diagnostic procedure and practices.

[2/0]
- **troubleshooting hydro mechanically governed engines**
- **troubleshooting electronically managed engines**
- **distinguishing hydro mechanical and electronic malfunctions on these engines**
- **sequential troubleshooting procedures**
- **EST snapshot testing**
- **EST performance test**
- **engine dynamometer**
- **chassis dynamometer**
- **road test procedures**

2.8.3 Describe the principles of symptom based engine diagnosis.

[2/0]
- **low power complaints**
- **engine vibration**
- **misfire complaint**
- **low oil pressure**
- **engine oil consumption**
- **high crankcase pressure**
- **component failures**
  - pistons
  - turbochargers
  - engine bearings
  - crankshafts
- **engine overheating**
- **hard starting problems**
- **exhaust smoke analysis**
- **black smoke**
- **blue smoke**
- **white smoke**

2.8.4 Perform inspection, testing and diagnostic procedures on diesel engines.

[0/3] **outline/perform:**
- **troubleshooting hydro mechanically governed engines**
- **troubleshooting electronically managed engines**
- **distinguishing hydro mechanical and electronic malfunctions on these engines**
- **cylinder leakage**
- **cylinder balance**
- **compression testing**
- **sequential troubleshooting procedures**
- **software driven sequential troubleshooting**
- **EST snapshot testing**
- **EST performance test**
- **engine dynamometer**
- **chassis dynamometer**
- **road test procedures**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and skin protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1293.9 Diesel Engine Run-in and Testing

Duration: Total 3 hours Theory 1 hour Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5138, 5139, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to describe how to break-in a new or rebuilt diesel engine and interpret dynamometer test result on diesel engines.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.9.1 Identify the functions, construction, composition, types, styles and application of diesel engine run-in and testing.

[0.5/0]
- **monitoring instrumentation**
- **engine and chassis onboard diagnostics**
- **chassis dynamometer**
- **engine dynamometer**
- **road test**
- **microprocessor base test instrumentation**
- **SAE J1939 protocols**

2.9.2 Explain the principle(s) of diesel engine run-in and testing

[0.5/0]
- **brake power calculations**
- **electromotive dynamometers**
- **hydro mechanical dynamometers**
- **microprocessor based test instrumentation**
- **analyzing performance graphs**

2.9.3 Describe inspection, testing and diagnostic procedures on diesel engines.

[0/2]
- **outline procedure for mounting diesel engines to an engine dynamometer test bed**
- **outline procedure for mounting trucks and coaches to a chassis dynamometer test bed**
- **review dynamometer safety procedures**
- **outline procedure for run-in testing of diesel engines**
- **outline procedure for diagnostic testing of diesel engines**
- **analyze download dynamometer test data**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and skin protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: S1294

Reportable Subject: **Electricity and Electronics**

Duration: Total 32 hours Theory 17 hours Practical 15 hours

Prerequisites: T.C. Level 2

Co-requisites: None

3.1 Heavy Duty Charging Circuits

12 Total Hours Theory: 8 hours Practical: 4 hours

3.2 Heavy Duty Electronic Ignition Systems

10 Total Hours Theory: 7 hours Practical: 3 hours

3.3 Electrical Component Reconditioning and Troubleshooting

10 Total Hours Theory: 2 hours Practical: 8 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
70%	30%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Functional truck or bus electrical system	DMMs
Full range electrical subcomponents for disassembly	Alternator test bench
AVR unit and load testing equipment	OEM diagnostic software
Electronic charging system diagnostic tooling	OEM data access including online service information systems (SIS)
Vehicle with spark ignitions	ESTs and CAs

S1294.1 Heavy Duty Charging Circuits

Duration: Total 12 hours Theory 8 hours Practical 4 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5136, 5137, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair heavy duty charging circuits.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

3.1.1 Explain the purpose and fundamentals off heavy duty charging circuits.

[2/0]
- **electronic basics**
- **diodes and transistors**
- **electromagnetism**
- **voltage induction principles**
- **inductive reactance of stator**
- **battery conditions as affecting internal resistance**
- **principles of tracing wiring schematics**
  - electrical / electronic symbols
  - Ohm's Law
  - temperature effects
- **factors affecting voltage and amperage output**
  - field strength
  - rotor speed
- **inductive reactance**

3.1.2 Identify the functions, construction, types, and application of heavy duty charging circuits.

[3/0]
- **brush type alternators**
- **rectifier**
- **stator**
- **delta, wye**
- **rotor**
- **field winding, poles, slip rings**
- **diode trio**
- **brush assembly**
- **case**
- **brushless alternators**
- **stationary field**
- **magnetic poles**

- **transformer multiple voltage system**
- **remote sensing regulators**
- **equalizer**
- **bearings**
- **pulleys**
- **drive gears**
- **drive gear adapters**
  - voltage regulators
  - external electronic
  - internal electronic
  - electronic digital
  - charge equalizer
- **cooling**
  - fans
  - oil
- **charge relays (bus and coach)**

3.1.3 Describe the principle(s) of operation of heavy duty charging circuits.

[3/0]
- **three-phase**
- **rectification**
  - full wave
  - half wave
- **induction principles**
- **alternating current**
- **differences between brush and brush less alternators**
- **dual voltage alternator**
- **transformer principle**
- **remote Sensing Regulators**
- **voltage regulator**
  - internal and external
  - electronic principles
  - load response
- **charger indicators**
- **equalizers**
- **low voltage disconnect (LVD) switches**

3.1.4 Perform inspection, testing and diagnostic procedures on heavy duty charging circuits.

[0/2]
- **perform charging system visual inspection of**
- **belt tension and alignment**
- **connections and wiring**
- **battery and alternator specifications and application**
- **outline recommended charging system-testing sequence**
- **perform battery condition tests**
- **perform charging circuit resistance voltage drop tests**
- **perform charging system current and voltage output tests**
- **identify specific charging system faults from test results**
- **demonstrate voltage regulator bench tests**
- **test electronic noise suppression devices**
- **LED fault display**

3.1.5 Recommend reconditioning or repairs following manufacturers' procedures on heavy duty charging circuits.

[0/2]
- **verify output capacity to satisfy the specific vehicle electrical load specifications**
- **adjust alternator drive belt tension and alignment**
- **disassemble, test, reconditioning and reassemble alternators**
- **repair oil cooled alternator**
- **outline voltage regulator rebuilding procedures**
- **performance test repairs on vehicle**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and skin protection
  - battery gas
  - explosion precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1294.2 Heavy Duty Electronic Ignition Systems

Duration: Total 10 hours Theory 7 hours Practical 3 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5137, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair heavy duty ignitions systems and components.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

3.2.1 Explain the purpose and fundamentals of heavy-duty electronic ignition systems.

[1/0]
- **electronic ignition systems**
- **electronic engine management**
- **distributorless ignition**
- **electromagnetism, electron theory**
- **semi-conductors, capacitance**
- **Ohm's law**
- **four-stroke cycle and spark timing**
- **centrifugal force**
- **ignition timing factors**
  - engine speed
  - load
  - temperature
  - detonation

3.2.2 Identify the functions, construction, types, styles and application of heavy-duty electronic ignition systems.

[2/0]
- **coils**
  - primary and secondary windings
- **distributors**
  - reluctor and pick-up coil
  - hall effect
  - optical
- **spark timing advance mechanisms**
  - mechanical
  - vacuum
  - computer controlled
- **secondary voltage output circuit**
  - high-tension spark plug wires
  - spark plugs

- coil and plug
- **ignition modules**
- **sensors**
  - crankshaft position
  - camshaft position
  - coolant temperature
  - knock sensor
  - manifold absolute pressure

3.2.3 Describe the principle(s) of operation of heavy-duty electronic ignition systems.

[4/0]
- **coils**
  - pulse transformer theory
  - capacitive discharge
  - coil and plug
  - distributors
  - reluctor and pick-up coil
  - hall effect
    - optical
- **spark timing advance mechanisms**
  - mechanical
  - vacuum
  - computer controlled
    - speed
    - load
    - temperature
    - detonation
- **secondary voltage output circuit**
  - high-tension spark plug wires
  - spark plugs
- **ignition modules**
- **sensors**
  - crankshaft position
  - camshaft position
  - coolant temperature
  - knock sensor
  - manifold absolute pressure

3.2.4 Perform inspection, testing and diagnostic procedures using an ignition analyzer (scope).

[0/2]
- **identify and locate electronic ignition system components on vehicles**
- **distributor components**
- **coils, ignition modules**
- **sensors**
- **switches**
- **wiring**
- **ignition timing and spark advance operation**
- **ignition coils and high-tension wires**
- **diagnose electronic ignition system component condition using recommended testing sequence**

3.2.5 Recommend reconditioning or repairs following manufacturers' procedures on heavy-duty electronic ignition systems.

[0/1]
- **replacing spark plugs**
- **diagnostic testing sequence**
- **coils and coil packs**
- **ignition modules**
- **sensors**
- **wiring and connections**
- **distributor components**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and face protection
  - battery gas venting
  - explosion precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1294.3 Electrical Component Reconditioning

Duration: Total 10 hours Theory 2 hours Practical 8 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5136, 5137

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to disassemble, repair, reassemble and diagnose heavy duty electrical components.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

3.3.1 Explain inspection, testing and diagnostic procedures on heavy-duty electrical components and circuits.

[1/2]
- **diagnose electrical auxiliary component malfunctions**
- **diagnose battery state of charge and condition**
- **diagnose cranking circuit malfunctions**
- **diagnose charging circuit malfunctions**
- **hard flow charts**
- **soft flow charts**
- **electronic circuit schematics**
- **software guided troubleshooting**
- **on-line troubleshooting**
- **sequential troubleshooting strategies**
- **software sequenced troubleshooting**
- **proprietary PC software**
- **truth table routing**
- **default modes**
- **audit trails**
- **tattletales**

3.3.2 Identify reconditioning or repairs following manufacturers' procedures on heavy-duty electrical components.

[1/6]
- **recondition truck electrical auxiliary components**
- **reconditioning truck electrical cranking motors**
- **recondition truck and coach AC generators**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and face protection
  - battery gas venting
  - explosion precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: S1295

Reportable Subject: **Fuel Systems**

Duration: Total 24 hours Theory 18 hours Practical 6 hours

Prerequisites: T.C. Level 2

Co-requisites: None

4.1 Hydraulically Actuated, Electronic Unit Injector (HEUI) Systems

6 Total Hours Theory: 5 hours Practical: 1 hour

4.2 Electronic Unit Pump (EUP) Systems

4 Total Hours Theory: 3 hours Practical: 1 hour

4.3 Time Pressure (TP), Electronic Common Rail Fuel Systems

5 Total Hours Theory: 4 hours Practical: 1 hour

4.4 Common Rail Accumulator Fuel Systems

9 Total Hours Theory: 6 hours Practical: 3 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
70%	30%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Functional electronically managed diesel engines equipped with HEUI, HPI-TP, EUP, and CR diesel fuel systems	Precision measuring tools
Full range of disassembled HEUIs, HPI-TPs, EUPs and CR-EHIs	Chassis or engine dynamometer
Injector timing and removal equipment	OEM diagnostic software
Fuel system sensor and actuator components for bench testing	OEM data access including online service information systems (SIS)
Diagnostic high pressure diagnostic gauges	ESTs and CAs

S1295.1 Hydraulically Actuated, Electronic Unit Injector (HEUI) Systems

Duration: Total 6 hours Theory 5 hours Practical 1 hour

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5138, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair of Hydraulically Actuated, Electronic Unit Injector (HEUI) Systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.1.1 Explain the purpose and fundamentals of HEUI fuel systems.

[1/0]
- **electronics**
- **computers**
- **input circuits**
- **electronics schematics**
- **hydraulics**
- **oil pumps**
- **fuel sub-systems**

4.1.2 Identify the functions, construction, types, and application of HEUI fuel systems.

[2/0]
- **system layout**
- **input circuits**
- **fuel circuit**
- **high-pressure oil circuits**
- **stepper pump**
  - injection pressure control module
  - injection pressure control regulator
- **HEUI assembly**
  - solenoid control
- **amplifier / intensifier piston**
- **plunger and chamber**
- **pilot/PRIME plungers**
- **hydraulics nozzles**
- **engine controller module (ECM)**

4.1.3 Describe the principle(s) of operation of HEUI fuel systems.

[2/0]
- **rail fuel flow**
- **high-pressure oil management**

- **HEUI actuation principles**
- **cold start / warm-up strategies**
- **emission control strategies**
- **injection rate control**
- **pilot/PRIME feature**
- **oil specifications**

4.1.4 Perform inspection, testing and diagnostic procedures on HEUI fuel systems.

[0/0.5]
- **service requirements**
- **troubleshooting strategies**
- **using diagnostic flow chart**
- **cylinder balance testing**
- **analyzing actuation voltage**
- **interpreting fault codes**
- **selecting and using the system appropriate EST**

4.1.5 Recommend reconditioning or repairs following manufacturers' procedures on HEUI fuel systems.

[0/0.5]
- **HEUI replacement precautions**
- **HEUI replacement procedure**
- **failure analysis**
- **customer data programming**
- **interpreting proprietary terminology and system differences**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, breathing, hearing and hand protection
  - electric shock precautions
  - high pressures / residual pressure
  - polarity precautions
  - electrostatic discharge precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1295.2 Electronic Unit Pump (EUP) Systems

Duration: Total 4 hours Theory 3 hours Practical 1 hour

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5138, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair Electronic Unit Pump Diesel Fuel Systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.2.1 Explain the purpose and fundamentals of electronic unit pump systems.

[1/0]
- **electricity**
- **electronics**
- **computers**
- **digital electronics**
- **input and output circuits**
- **characteristics of cam geometry**

4.2.2 Identify the functions, construction, and application of electronic unit pump systems

[1/0]
- **ECMs: chassis and engine/fuel controllers**
- **switching apparatus**
- **interface modules**
- **pump driver units**
- **EUP components**
  - solenoid cartridge valves
  - tappet, plunger and barrel assemblies
  - charge fuel routing
- **hydraulic nozzle assemblies**
- **electrohydraulic injectors (EHIs)**
- **high-pressure pipes**
- **distinguishing factors between different EUP systems**

4.2.3 Describe the principle(s) of operation of electronic unit pump systems.

[1/0]
- **pump driver units**
- **actuation voltage characteristics**
- **electronic unit pumps**
  - control solenoid cartridges
  - injection pumping components
- **hydraulic nozzles**
- **electrohydraulic injector (EHIs) control**
- **high-pressure pipes**
- **effective stroke control**
- **pilot injection**
- **default modes**
- **tattletale / audit trail logging**
- **effective stroke duty cycle/pulse width**

4.2.4 Perform inspection, testing and diagnostic procedures electronic unit pump systems

[0/0.5]
- **analyze customer data programming**
- **analyze proprietary data programming**
- **perform sequential troubleshooting using OEM text**
- **analyze circuit malfunctions**
- **perform an electronic EUP cutout test**
- **perform a snapshot test**

4.2.5 Recommend reconditioning or repairs following manufacturers' procedures on electronic unit pump systems.

[0/0.5]
- **outline procedure for diagnosing electronic malfunctions**
- **outline procedure for diagnosing hydromechanical malfunctions**
- **demonstrate proprietary data download procedures**
- **outline procedure for removing and replacing EUPs**
- **program customer engine and chassis data to an ECM**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, breathing, hearing and hand protection
  - electric shock precautions
  - high pressures / residual pressure
  - polarity precautions
  - electrostatic discharge precautions
- **communications**
  - information accessing practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1295.3 Time Pressure (TP), Electronic Common Rail Fuel Systems

Duration: Total 5 hours Theory 4 hours Practical 1 hour

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5138, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair time-pressure (TP), electronic common rail systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.3.1 Explain the purpose and fundamentals of Time Pressure (TP), electronic common rail fuel systems.

[1/0]
- **fuel sub-systems**
- **time pressure hydraulic equation**
- **dual cam geometry**
- **quiescent combustion**

4.3.2 Identify the functions, construction, and application of Time Pressure (TP), electronic common rail fuel systems.

[1/0]
- **fuel sub-system**
- **HPI-TP Injectors**
- **plunger and cup**
- **timing chamber**
- **timing solenoid**
- **metering solenoid**
- **cylinder head configuration**
- **ECM fuel flow routing**

4.3.3 Describe the principle(s) of operation of Time Pressure (TP), electronic common rail fuel systems.

[2/0]
- **common rail, time-pressure theory**
- **rail pressure management**
- **metering solenoid functions**
- **timing solenoid function**
- **flow controls**
- **dual camshaft functions**
- **engine brake management**
- **injector timing**

- **effective stroke characteristics**
  trapped volume spill (TVS) management

4.3.4 Perform inspection, testing and diagnostic procedures on Time Pressure (TP), electronic common rail fuel systems.

[0/0.5]
- **demonstrate adjustment procedure HPI-TP Injectors**
- **demonstrate priming procedure**
- **demonstrate electronic cylinder cutout procedure**
- **troubleshooting strategies**

4.3.5 Recommend reconditioning or repairs following manufacturers' procedures on Time Pressure (TP), electronic common rail fuel systems.

[0/0.5]
- **demonstrate engine timing fear procedure**
- **demonstrate electronically guided trouble shooting procedures**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - high pressure / skin penetration
  - ventilation
  - explosion hazard of atomized fuel
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1295.4 Common Rail Fuel Systems

Duration: Total 9 hours Theory 6 hours Practical 3 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5138, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair of electronically controlled, common rail accumulator, high pressure injection pumps.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.4.1 Explain the purpose and fundamentals of Common Rail, Accumulator Fuel Systems.

[1/0]
- **fuel sub-systems**
- **fuel circuit schematic**
- **fueling hydraulic equations**
- **fuel sub-system**
- **linear proportioning solenoids**
- **injector actuation and controls**

4.4.2 Identify the functions, construction, and application of Common Rail, Accumulator Fuel Systems.

[2/0]
- **fuel sub-system**
- **electrohydraulic Injectors (EHI)**
  - solenoid –actuated
  - piezo-actuated
- **fuel rail design**
- **Fuel Amplified Common Rail Systems (FACR)**
  - intensifier piston
  - amplification ratios
- **high pressure pipes**
- **quill/transfer tubes**
- **low pressure fuel flow routing**
- **high pressure fuel flow routing**

4.4.3 Describe the principle(s) of operation of Common Rail, Accumulator Fuel Systems.

[3/0]
- **common rail fuel equations**
- **rail pressure management**
  - desired pressure/actual pressure
  - rail pressure regulator
  - rail pressure sensors
- **flow controls**
- **pump characteristics**
- **injection controls**
  - solenoid actuators
  - piezo actuators
- **Fuel Amplified Common Rail Systems (FACR)**
- **fuel rate shaping**
- **multi-pulse injection**

4.4.4 Perform inspection, testing & diagnostic procedures following manufacturers' recommendations on common rail systems

[0/3]
- **cylinder balance test**
- **static actuator test**
- **test data analysis**
- **outline procedure for removing/replacing high pressure pipes**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - high pressure / skin penetration
  - ventilation
  - explosion hazard of atomized fuel
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention system
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: S1296

Reportable Subject: **Vehicle Electronic Management and Emissions Systems**

Duration: Total 32 hours Theory 21 hours Practical 11 hours

Prerequisites: T.C. Level 2

Co-requisites: None

5.1 Customer and Proprietary Data Programming

6 Total Hours Theory: 3 hours Practical: 3 hours

5.2 Multiplexing

6 Total Hours Theory: 4 hours Practical: 2 hours

5.3 Emission controls and testing

8 Total Hours Theory: 5 hours Practical: 3 hours

5.4 Hybrid Drive Systems

8 Total Hours Theory: 6 hours Practical: 2 hours

5.5 Collision avoidance systems

4 Total Hours Theory: 3 hours Practical: 1 hour

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
70%	30%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Functional truck or bus with fully multiplexed network	Access to series or parallel hybrid drive chassis
Functional truck equipped with C-EGR, oxidizing and reduction catalysts, DPF, and urea injection system	Exhaust gas analyzer and opacity measurement equipment
Software to drive DPF regeneration	OEM diagnostic software
Vehicle equipped with a CAS or a CAS simulator (VORAD simulator)	OEM data access including online service information systems (SIS)
Specialty sealed connector assembly and repair tools	ESTs and CAs

S1296.1 Customer and Proprietary Data Programming

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5136, 5137, 5140, 5142, 5150, 5151

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the difference between customer and proprietary data programming and outline the procedure required to perform vehicle computer programming.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.1.1 Explain the purpose and fundamentals of customer and proprietary data programming.

[1/0]
- **electronics**
- **computers**
- **ESTs**
- **telecommunications**

5.1.2 Identify the functions, construction and application of customer and proprietary data programming.

[1/0]
- **ESTs**
- **generic reader / programmers**
- **proprietary reader / programmers**
- **dash data switches**
- **PCs**
- **SAE J1939 and J1708 data connectors**
- **serial linkages and modules**
- **modems**
- **hard and soft telecommunications devices**

5.1.3 Describe the principle(s) of operation of customer and proprietary data programming.

[1/0]
- **data retention**
- **types of programming**
- **PROM**
- **EEPROM**
- **flash programming**
- **non-volatile RAM**
- **magnetic data retention**
- **electronic data retention**

- **optical data retention**
- **programming instruments**
- **programming security**
- **programming protocols**
- **SAE J1939 codes and protocols**
  - mainframe data hubs
- **wireless interface**

5.1.4 Perform customer and proprietary data programming using the appropriate ESTs and truck chassis or simulators.

[0/3]
- **download customer data engine parameters**
- **download chassis data**
- **diagnose engine and chassis conditions from downloaded data**
- **convert codes and audit trails**
- **verify the need for proprietary reprogramming of an ECM**
- **specification reprogramming**
- **corrupted retained data**
- **proprietary upgrade**
- **perform customer data programming to an ECM using an EST on a truck, coach or simulator**
- **road speed**
- **tire rolling radii programming factors**
- **transmission ratio programming factors**
- **reprogram a throttle position sensor-operating window**
- **download proprietary data to diskettes or ECM**
- **reprogram engine / chassis data**
- **upload verification files to data hub**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, breathing, hearing and hand protection
  - electric shock precautions
  - high pressures / residual pressure
  - polarity precaution
  - electrostatic discharge precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1296.2 Multiplexing

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5136, 5138, 5140, 5141, 5142, 5150, 5151

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the basics of vehicle electronic system multiplexing and describe how digital communications can reduce the complexity of control circuits.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.2.1 Explain the purpose and fundamentals of vehicle multiplexing communications.

[1/0]
- **electronics**
- **computers**
- **digital signals**
- **networking**
- **binary system**
- **information packets**

5.2.2 Identify the functions, construction and application of vehicle multiplexing systems.

[1/0]
- **Control area network (CAN) fundamentals**
- **SAE J1587/1708 data protocols**
- **SAE J1939 data protocols**
- **power line carrier (PLC) communications (trailers)**
- **communication adapters (CAs)**
- **module addresses on the data bus**
- **transaction frequency**
- **data packet architecture**
- **electromagnetic interference (EMI)**
- **ladder switches**
- **silicon controlled rectifier (SCR) switching**
- **twisted wire pairs**
  - Hi bus
  - Lo bus
- **terminating resistors**
- **data connectors**

5.2.3 Describe the principle(s) of operation of vehicle multiplexing systems.

[2/0]
- **CAN data protocols and ISO 9141**
- **SAE J1587/1708**
- **SAE J1939 data protocols**
- **clock speeds**
- **bandwidth**
- **neural network**
- **bus topology**
- **packet architecture**
  - bus negotiation
  - arbitration field
  - data field
  - acknowledgement field
- **information coding**
- **ladder switches**

5.2.4 Navigate the data bus on a truck or coach chassis or simulator accessing MIDs, PIDs, SIDs, and FMIs using the appropriate ESTs.

[0/2]
- **identify high and low bus twisted wire pairs**
- **identify J1708 and J1939 data connectors**
- **navigate MIDs, PIDs, and SIDs**
- **log and erase fault codes**
- **outline repair procedures according to manufacturer procedures**
- **download chassis data**
- **identify location of MIDs on a chassis**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, breathing, hearing and hand protection
  - electric shock precautions
  - polarity precautions
  - electrostatic discharge precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention system
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1296.3 Emission Controls and Testing

Duration: Total 8 hours Theory 5 hours Practical 3 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5137, 5138, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair emission control devices and system on trucks and coaches.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.3.1 Explain the purpose and fundamentals of emission controls and testing.

[1/0]
- **fuel chemistry**
- **engine theory**
- **engine breathing**
- **engine exhaust systems**
- **combustion dynamics**
- **electronics**
- **engine emissions**
  - CO
  - NOx
  - HC
  - Particulate matter
  - SO & SO_2
- **carbon footprint**
- **greenhouse gases (GHGs)**

5.3.2 Identify the functions, types, and application of emission controls and testing.

[1/0]
- **pre-combustion noxious emission control devices**
- **boost air management**
- **charge air heat exchangers**
- **sealed fuel sub-systems**
- **post-combustion noxious emission control devices**
  - diesel particulate filters (DPFs)
    - catalyzed
    - non catalyzed
  - DPF regeneration cycles
  - single stage, oxidizing catalytic converters
  - dual stage, oxidation and reduction catalytic converters
  - NOx adsorption catalysts
  - selective catalytic reduction (SCR)

  - EGR systems
  - crankcase emissions control
- **S.I. emission controls**
- **C.I. emission controls**
- **closed loop factors in SI engines**
- **sealed evaporative emissions control**

5.3.3 Describe the principles of noxious emissions, emission control devices and testing mechanisms.

[3/0]
- **photochemical smog composition**
- **NOx, HC emission**
- **evaporative emission controls**
- **cylinder combustion temperature management**
- **O_2 sensors**
- **NOx sensors**
- **pressure differential sensor**
- **closed loop operation**
- **EGR principles**
- **oxidation catalysts**
- **reduction catalysts**
- **NOx adsorption catalysts**
- **SCR**
- **sonic emissions**
- **S.I. noxious emissions**
- **C.I. noxious emissions**
- **lean, stoichiometric and rich burn factors**
- **combustion temperature effect on emissions**

5.3.4 Perform inspection, testing and diagnostic procedures on emission controls.

[0/2]
- **perform exhaust gas analysis on diesel engines**
- **perform exhaust gas analysis on gasoline engines**
- **perform smoke analysis tests**
- **analyze opacity meter test codes**
- **measure exhaust gas temperature using a pyrometer**
- **diagnose engine-running conditions using an infrared thermometer**
- **outline DPF regeneration**

5.3.5 Recommend reconditioning or repairs following manufacturers' procedures on emission controls.

[0/1]
- **analyze emission control instruments results and recommend repairs as prescribed in OEM literature**

GENERAL PRACTICES

safety precautions

- eye, breathing, hearing and hand protection
- rotating shafts, belts and pulleys
- high pressure / residual pressure
- polarity precautions

communications

- opacimeter
- information accessing
- practical report
- technical service bulletins
- data retention systems
  - service records
  - service information systems
  - electronic format
- current legislated requirements
- WHMIS

mathematics

- système international d'unités (s.i.) to Imperial conversion

S1296.4 Hybrid Drive Systems

Duration: Total 8 hours Theory 6 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5136, 5137, 5140, 5152

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the operating principles and perform repairs on hybrid drive (diesel/electric) systems and their control mechanisms.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.4.1 Explain the purpose and fundamentals of a hybrid drive systems.

[1/0]
- **diesel power units**
- **electric drive motors**
- **hydraulic motors and accumulators**
- **hydraulic regeneration**
- **gear sets**

5.4.2 Identify the functions, construction, and application of hybrid drive systems.

[1/0]
- **diesel power units**
- **gas turbine power units**
- **electric drive motors**
- **blended torque transmissions**
- **battery banks**
  - nickel metal hydride (NiMH)
  - lithium ion (LiOn)
- **inverters**
- **ultracapacitors**
- **hydraulic regeneration**

5.4.3 Describe the principle(s) of operation and advantages of hybrid drive systems

[4/0]
- **generator principles**
- **isochronous governing**
- **regenerative braking**
- **hydraulic regeneration**
- **emissions**
- **multiplexing**
- **drive gear trains**
- **urban transit applications**
- **less-than-load (LTL) applications**

- **hybrid electric powertrains**
  - series driven
  - parallel driven
- **series hydraulic hybrid (SHH)**
- **parallel hydraulic hybrid (PHH)**
- **electronic steering assist**

5.4.4 Recommend reconditioning or repairs following manufacturers procedures on emission controls .

[0/2]
- **identify high electrical potential circuits**
- **distinguish chassis electrical circuits from – powertrain electrical circuits**
- **use wiring schematics to identify high potential electrical components**
- **outline procedure to isolate ~~neutralize~~ high potential battery banks**
- **outline procedure to neutralize high potential capacitor banks**
- **outline procedure required to equalize accumulator and residual pressures in hydraulic circuits**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - rotating components
  - hazards of spring tension
  - hazards of high voltage circuits
  - hazards of high residual pressures in hydraulic circuits
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - code retrieval
    - audit trails
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1296.5 Collision Avoidance Systems

Duration: Total 4 hours Theory 3 hours Practical 1 hour

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5137, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to describe the operating principles of typical collision avoidance systems, identify the system hardware and access stored data in the system.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.5.1 Explain the purpose and fundamentals of truck and coach Collision Avoidance Systems

[1/0]
- **doppler effect**
- **yaw and rollover detection**
- **chassis multiplexing**
- **MID negotiation on data bus**
- **video processing**

5.5.2 Identify the construction, composition, type, styles and application of truck and coach Collision Avoidance Systems.

[1/0]
- **microwave sensor**
- **radar antenna**
- **driver display unit**
- **doppler radar based systems**
- **video based systems**
  - back-up scanning
  - lane guidance systems
  - programmable logic controllers (PLCs)
- **accelerometer systems**
- **lane Guidance Systems**

5.5.3 Describe the principle(s) of operation of truck and coach Collision Avoidance Systems

[1/0]
- **doppler effect**
- **frequency shift analysis**
- **microwave**
- **data collection and retention**
- **lane Guidance Systems**

5.5.4 Perform the inspection, testing and diagnostic procedures for truck and coach Collision Avoidance Systems

[0/1]
- **collision-analysis profiles**
- **access Proximity Data**
- **system programming**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing and skin protection
  - potential lifting hazards
  - circuit protection requirements of handling electronically controlled systems
  - electrostatic discharge precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: S1297

Reportable Subject: **Drive Trains**

Duration: Total 40 hours Theory 22 hours Practical 18 hours

Prerequisites: T.C. Level 2

Co-requisites: None

6.1 Torque Converters

5 Total Hours Theory: 3 hours Practical: 2 hours

6.2 Automatic Transmissions and Vehicle Retarders

20 Total Hours Theory: 10 hours Practical: 10 hours

6.3 Electronically Controlled Automatic Transmissions

12 Total Hours Theory: 7 hours Practical: 5 hours

6.4 Transfer Case, Drop Box and Power Take-Off Assemblies

3 Total Hours Theory: 2 hours Practical: 1 hour

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
55%	45%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Functional truck with an electronically managed automatic transmission	Precision measuring tools
Full range of disassembled automatic transmission components	Transmission overhaul stands
Assortment of failed transmission components for failure analysis	OEM diagnostic software
Hydromechanical and electronic automatic transmissions for disassembly and reassembly	OEM data access including online service information systems (SIS)
Specialty transmission tools	ESTs and CAs

S1297.1 Torque Converters

Duration: Total 5 hours Theory 3 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5142

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair truck and coach torque converter units.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.1.1 Explain the history, purpose and fundamentals of torque converter assemblies.

[1/0]
- **torque converters**
- **fluid clutch**
- **hydraulic force**
- **kinetic energy**
- **centrifugal force**

6.1.2 Identify the functions, construction, composition, types, styles and application of torque converter assemblies.

[1/0]
- **torque converters**
  - one-piece
  - multi-piece
- **impeller**
- **turbine**
- **stator**
  - conventional
  - variable pitch
- **overrunning clutch**
- **lockup clutch**

6.1.3 Describe the principle(s) of operation of torque converter assemblies.

[1/0]
- **torque converters**
  - one-piece
  - multi-piece
- **impeller**
- **turbine**
- **stator**
  - conventional
  - variable pitch

- **overrunning clutch**
- **lockup clutch**
- **vortex flow**
- **rotary flow**
- **torque multiplication phase**
- **coupling phase**
- **converter lockup**
- **coupling phase**

6.1.4 Perform inspection, testing and diagnostic procedures on torque converter assemblies.

[0/1]
- **fluid level check**
- **fluid condition**
- **visual inspection**
- **converter endplay check**
- **demonstration of stall test procedure**
- **performance testing**

6.1.5 Recommend reconditioning or repairs following manufacturers' procedures on torque converter assemblies.

[0/1]
- **outline procedure for checking fluid levels**
- **outline recommended fluid change intervals**
- **verify fluid type and application**
- **converter removal, disassembly, (multi-piece), reassemble (multi-piece) and**
- **replacement procedure**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye and hand protection
  - precision measuring tool precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

1297.2 Automatic Transmissions and Vehicle Retarders

Duration: Total 20 hours Theory 10 hours Practical 10 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5137, 5140, 5142

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair automatic transmissions and vehicle retarders to manufacturer's standards.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.2.1 Explain the purpose and fundamentals of automatic transmissions and vehicle retarders.

[2/0]
- **mechanical advantage**
- **laws of Levers**
- **torque**
- **gear ratios**
- **shaft and splines**
- **planetary gearing**
- **gear train control devices**
- **hydraulic control systems**
- **power flows**
- **thrust loads**
- **lubrication system**
- **hydraulic fluid and principles**
- **retarders and controls**

6.2.2 Identify the functions, construction, and application of automatic transmissions and vehicle retarders.

[3/0]
- **planetary gear trains**
  - simple
  - compound
- **gear train control devices**
  - hydraulic clutches
- **pumps, drives and controls**
- **valve bodies**
  - spool valves
  - pressure regulating devices
  - flow control devices
  - directional control devices
  - shift cushioning devices
- **throttle / modulator valves and circuits**

- **governor valves and circuits**
- **shift mechanisms**
- **automatic upshifting and downshifting**
- **lubrication system**
- **parking devices**

6.2.3 Describe the principle(s) of operation of automatic transmissions and vehicle retarders.

[5/0]
- **planetary gear trains**
  - simple
  - compound
- **gear train control devices**
  - one way clutched
  - band and servo mechanisms
  - hydraulic clutches
- **pumps, drives ad controls**
- **valve bodies**
  - spool valves
  - pressure regulating devices
  - flow control devices
  - directional control devices
  - shift cushioning devices
- **throttle / modulation valves and circuits**
- **shift mechanisms**
- **automatic upshifting and downshifting**
- **lubrication system**
- **parking devices**
- **retarders and controls**

6.2.4 Perform disassembly, inspection, reassembly, testing and diagnostic procedures on automatic transmissions and vehicle retarders.

[0/5]
- **disassemble**
- **visual inspection**
- **reassemble**
- **noise analysis**
- **temperature analysis**
- **performance testing**
- **fluid level and condition**
- **pressure testing**
- **stall testing procedure**

6.2.5 Recommend reconditioning or repairs following manufacturers' procedures on automatic transmissions and retarders.

[0/0.5]
- **outline procedure for checking fluid level**
- **outline recommended lubrication change intervals and procedures**
- **verify lubricant type and application**
- **transmission removal, disassembly, reassembly and replacement procedure**
- **failure analysis to identify:**
  - friction material
  - seals and gaskets and O rings
  - gear and shafts
  - bushings and bearings
  - pump drives and controls
  - valve body and governor test stand

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hand, breathing, hearing and foot protection
  - lifting precautions of transmissions
  - clamping and holding
  - compressed springs
  - use of air to dry and test components
  - oil pressure
  - hoist and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1297.3 Electronically Controlled Automatic Transmissions

Duration: Total 12 hours Theory 7 hours Practical 5 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5137, 5140, 5142

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair electronically controlled automatic transmissions.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.3.1 Explain the purpose and fundamentals of electronically controlled automatic transmissions.

[2/0]
- **shift point control**
  - engine load
  - driver input
  - road speed
- **digital electronics**
- **input and output circuits**
- **hydraulics**

6.3.2 Identify the functions, construction, composition, types, styles and application of electronically controlled automatic transmissions.

[2/0]
- **electronic shift control systems**
- **input signals**
  - vehicle speed sensor
  - engine speed sensor
  - turbine speed sensor
  - pressure sensor
  - temperature sensor
  - fluid level sensor
  - shift selector
- **output actuators**
  - latching solenoids
  - non-latching solenoids
  - normally open solenoids
  - normally closed solenoids
  - connectors and harnesses
- **ECM**
- **interface module**

6.3.3 Describe the principle(s) of operation of electronically controlled automatic transmissions.

[3/0]

- **input signal mechanisms (sensors)**
  - vehicle speed
  - engine speed (load)
  - turbine speed
  - pressure
  - temperature
  - shift selector
  - solenoids
- **output actuators**
  - latching solenoids
  - non-latching solenoids
  - pulse width modulation
  - modulated solenoids
    - normally open solenoids
    - normally closed solenoids
- **ECM / ECU**
  - electronic shift quality control
- **interface modules**
- **customer data reprogramming**
- **default modes**
- **data link protocols**

6.3.4 Perform inspection, testing and diagnostic procedures on electronically controlled automatic transmissions.

[0/2]

- **visual inspection**
- **pressure testing**
- **fluid level and condition**
- **digital multimeter**
- **EST**
- **sequential troubleshooting strategies**
- **interpretation of schematics**
  - electrical
  - hydraulic
- **fault code interpretation**
- **retrieving and clearing fault codes**
  - EST (Electronic Service Tool)
  - shift selector

6.3.5 Recommend reconditioning or repairs following manufacturers' procedures on electronically controlled automatic transmissions.

[0/3]
- **performance testing**
- **identify harness and connector failures**
- **sensor / actuator replacement**
- **potentiometer calibration / adjustment**
- **ECM replacement**
- **PROM replacement**
- **maintenance / repair precautions**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hand, breathing, hearing and foot protection
  - lifting precautions of transmissions
  - clamping and holding
  - compressed springs
  - use of air to dry and test components
  - oil pressure
  - hoist and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1297.4 Transfer Case, Drop Box and Power Take-Off Assemblies

Duration: Total 3 hours Theory 2 hours Practical 1 hour

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5142

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair transfer case, drop box and power take-off assemblies.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.4.1 Explain the purpose and fundamentals of transfer case, drop box and power take-off assemblies.

[0.5/0]
- **mechanical advantage**
- **laws of levers**
- **torque**
- **input / output rotational speed**
- **gear ratios**
- **shafts, splines and gears**
- **lubrication**

6.4.2 Identify the function, construction, composition, types, styles and application of transfer case, drop box and power take-off assemblies.

[0.5/0]
- **clutching mechanisms**
- **case**
- **gears**
- **shafts**
- **bearings and bushings**
- **spacers and thrust washer**
- **seals and gaskets**
- **shifting mechanisms**

6.4.3 Describe the principle(s) of operation of transfer case drop box and power take-off assemblies.

[1/0]
- **gears**
- **clutching mechanisms**
- **bearings and bushings**
- **shafts and splines**
- **thrust control seals and gaskets**
- **shift mechanisms**

- **power flow**
- **lubrication system**
- **PTO backlash**

6.4.4 Perform inspection, testing and diagnostic procedure on transfer case drop box and power take-off assemblies.

[0/0.5]
- **visual inspection**
- **performance test**
- **temperature testing**
- **thrust measurement**
- **fluid level condition**
- **verify power flow**

6.4.5. Recommend reconditioning or repairs following manufacturers' procedures on transfer case, drop box and power take off assemblies.

[0/0.5]
- **outline procedures for checking lubricant levels**
- **outline recommended lubricant change intervals and procedure**
- **verify lubricant type and application**
- **component and controls / shift mechanism,**
- **removal, disassembly, reassembly and replacement procedure**
- **failure analysis to identify**
  - shock failures
  - fatigue failures
  - torsional failure
  - surface failures

GENERAL PRACTICES

- **safety precautions**
  - eye, hand, breathing, hearing and foot protection
  - lifting precautions of transmissions
  - clamping and holding
  - compressed springs
  - use of air to dry and test components
  - oil pressure hoist and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention system
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: S1298

Reportable Subject: **Steering, Suspension and Brake Systems**

Duration: Total 48 hours Theory 25 hours Practical 23 hours

Prerequisites: T.C. Level 2

Co-requisites: None

7.1 Pneumatic Circuit Interpretation and Analysis

4 Total Hours Theory: 2 hours Practical: 2 hours

7.2 Brake System Diagnostics

4 Total Hours Theory: 1 hour Practical: 3 hours

7.3 Anti-lock Braking Systems (ABS), Automatic Traction Control (ATC) and Roll and Directional Stability (RDS) Systems

6 Total Hours Theory: 4 hours Practical: 2 hours

7.4 Medium and Heavy Duty Steering Axle Systems

6 Total Hours Theory: 4 hours Practical: 2 hours

7.5 Medium and Heavy Duty Vehicle Alignment

6 Total Hours Theory: 2 hours Practical: 4 hours

7.6 Mechanical Steering Gear

4 Total Hours Theory: 2 hours Practical: 2 hours

7.7 Hydraulic Power Assist Steering Gear

6 Total Hours Theory: 3 hours Practical: 3 hours

7.8 Truck, Coach, Bus and Trailer Frames and Bodies

6 Total Hours Theory: 4 hours Practical: 2 hours

7.9 Truck and Coach Coupling Devices

6 Total Hours Theory: 3 hours Practical: 3 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
50%	50%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Functional truck or bus equipped with ABS	Precision measuring tools
Full range of disassembled brake and steering system components	Frame measuring equipment
Brake balance diagnostic software and pneumatic schematics in hard or soft formats	Assortment of fifth wheels for disassembly, reassembly, and adjustment
Wheel end equipment	OEM data access including online service information systems (SIS)
Assortment of steering gear for disassembly, reassembly and adjustment.	ESTs and CAs

S1298.1 Pneumatic Circuit Interpretation and Analysis

Duration: Total 4 hours Theory 2 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5146, 5149, 5150

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to interpret pneumatic schematic symbols and circuits and use schematics to troubleshoot typical vehicle problems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.1.1 Explain the purpose and fundamentals of pneumatic circuit interpretation and analysis.

[1/0]
- **fluid power**
- **pneumatic schematics**
- **brake theory**
- **potential energy**

7.1.2 Identify the functions, types, and application of pneumatic circuit interpretation and analysis.

[1/0]
- **air control circuits**
- **air brake circuits**
- **auxiliary component circuits**
- **air suspensions**

7.1.3 Describe interpretation and diagnostic procedures on pneumatic circuits.

[0/2]
- **interpret pneumatic schematics and symbols**
- **locate critical pneumatic system components**
- **perform pressure tests on pneumatic circuit components at critical junctions**
- **verify the performance of pneumatic valves**
- **outline procedure for checking and repairing leaks**
- **outline procedure for fabricating pneumatic lines and hoses**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - hoist, jack and stand use
  - air pressure protection
  - grease and friction materials
  - electronic system static electricity precautions
  - bending precautions
- **communications**
  - information accessing
  - practical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1298.2 Brake System Troubleshooting

Duration: Total 4 hours Theory 1 hour Practical 3 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5149, 5150, 5152

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to perform air brake troubleshooting using service literature, air brake schematics and test instruments.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.2.1 Explain the purpose and fundamentals of brake system troubleshooting.

[0.5/0]
- **foundation brakes**
- **stroke length**
- **automatic slack adjusters**
- **outline procedure for air compressor, air dryer, air receiver, testing**
- **test and adjust governors**
- **test control valves for recommended operation**
- **brake torque balance**
- **brake timing**
- **pneumatic schematics**
- **statutory inspection safety criteria**

7.2.2 Identify the functions and application of brake system troubleshooting.

[0.5/0]
- **air brake systems**
- **hydraulic brake systems**
- **air over hydraulic brake systems**

7.2.3 Describe inspection, testing and diagnostic procedures on brake systems.

[0/2]
- **use an OEM brake schematic to diagnostic brake system problems**
- **outline procedure for diagnosing typical brake system malfunctions**
- **outline the factors required to torque balance brake performance**
- **troubleshoot brake torque imbalance conditions such as wheel hop**
- **verify the performance of brake system control valves**
- **outline the requirements for brake system pneumatic timing**
- **use gauges to verify pneumatic timing**
- **outline crack pressure requirements of relay valves**

7.2.4 Perform reconditioning or repairs following manufacturers' procedures on brake systems.

[0/1]
- **outline procedure requires to recondition on balance a brake system to manufacturer's and statutory standards**
- **outline requirements for a road test to verify vehicle-braking performance**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - hoist, jack and stand use
  - air pressure protection
  - grease and friction materials
  - electronic system static electricity precautions
  - bending precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1298.3 Anti-lock Braking Systems (ABS), Automatic Traction Control (ATC) and Roll and Directional Stability (RDS) Systems

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5137, 5140, 5150

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair ABS, ATC and RDS Systems to manufacturer and statutory standards.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.3.1 Explain the purpose and fundamentals of ABS, ATC and RDS systems

[1/0]
- **pneumatic brake system fundamentals**
- **electrical fundamentals**
- **computer fundamentals**

7.3.2 Identify the functions, construction, types, and application of ABS, ATC and RDS systems as per manufacturers' specifications.

[1/0]
- **anti-lock brake hardware**
- **electronic control modules (ECM)**
- **anti-lock modulator controller**
- **traction control module**
- **wheel sensors**
- **fail relays**
- **diagnostic displays**
- **trailer ABS systems**
- **tractor/trailer signaling and warnings**
- **accelerometers**
- **gyroscopic sensors**

7.3.3 Describe the principle(s) of operation of ABS, ATC and RDS systems.

[2/0]
- **electronic control module (ECM)**
- **anti-lock modulator controller**
- **traction control module**
- **wheel sensors**
- **fail relay**
- **pneumatic timing**
- **brake balance**
- **brake phasing**

- **valve crack pressures**
- **dynamic braking effect**
- **load transfer**
- **pressure protection devices**
- **brake system management from tractor**
- **multiplexing**
- **SAE J1939 requirements**
- **active suspension / brake / traction control systems**
- **trailer ABS**
- **tractor/ trailer communications**
- **gyroscopic sensors**
- **yaw evaluation**

7.3.4 Perform inspection, testing and diagnostic procedures on ABS, ATC, and RDS systems

[0/1]
- **overview current truck and coach ABS systems**
- **outline dynamic and static testing**
- **fault code interpretation**
- **electronic control module (ECM)**
- **anti-lock modulator controller**
- **traction control module**
- **roll and directional tracking sensors**
- **wheel sensors**
- **fail relay**
- **pneumatic timing**
  - brake balance
  - brake phasing
  - valve crack pressures
  - dynamic braking effect
  - load transfer
- **verify traction control operation**
- **static discharge precautions**
- **distinguish between electronic and pneumatic malfunctions**

7.3.5 Recommend reconditioning or repairs following manufacturers' procedures on ABS, ATC and RDS systems.

[0/1]
- **perform prescribed preventive maintenance checks**
- **outline procedure for removal and replacement**
- **ABS / ATC/ RSC modules**
- **programming options**
- **Input circuit components**
- **output circuit components**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye and hand protection
  - hoist, jack and stand use
  - air pressure protection
  - grease and friction materials
  - high-pressure auto grease systems
  - electronic system static electricity precautions
- **communications**
  - information accessing
  - practical report
  - system schematics and symbols
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1298.4 Medium and Heavy Duty Steering Axle Systems

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5146, 5147, 5148

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair of ABS and ATC Systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.4.1 Explain the purpose and fundamentals of medium and heavy-duty steer axle systems.

[1/0]
- **solid axle**
- **twin "I" beam**
- **fully independent**
- **caster**
- **KPI**
- **tow**
- **vehicle tracking**

7.4.2 Identify the functions, construction, composition, types, styles and applications of medium and heavy duty steer axle systems.

[1/0]
- **solid and twin I beam front axles**
- **steering knuckles**
- **drag links**
  - one piece
  - two piece
    - steering arms (Ackerman arms)
    - kingpins
    - tie rods and tie rod ends
- **pitman arms**
- **fully independent**
- **control arms**
- **center-link**
- **pitman arm**
- **idler arms**
- **ball joints (tension and compression)**
- **steering arms (Ackerman arms)**
- **knuckle (spindle)**
- **tie rods (inner and outer)**
- **steering control rods (rack and pinion)**

- **dual steer axles**
- **coil springs**
- **steering dampeners**
- **shock absorbers**
- **tandem axle alignment**

7.4.3 Describe the principle(s) of operation of medium and heavy duty steer axle systems.

[2/0]
- **solid axle**
- **twin I beam front axles**
- **fully independent**
  - dual steer axles
  - steering geometry
    - Ackerman's principle
    - caster
    - camber
    - steering axis inclination
    - kingpin
    - ball joint

7.4.4 Perform inspection, testing and diagnostic procedures on medium and heavy-duty steer axle systems.

[0/1]
- **visual inspection of components**
  - wear
  - loose
  - damage
  - defective
- **outline the procedure for front axle king pin replacement.**

7.4.5 Recommend reconditioning or repairs following manufacturers' procedures on medium and heavy-duty steer axle systems.

[0/1]
- **outline maintenance and servicing of:**
  - solid axle system components
  - twin I beam system components
  - independent suspension components
  - coil springs
- **outline OEM wear limits**
- **outline safety check procedures**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - hoists, hacks and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1298.5 Medium and Heavy Duty Vehicle Alignment

Duration: Total 6 hours Theory 2 hours Practical 4 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5147.03, 5147.05

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair vehicle alignment components and be able to perform adjustments to manufacturer and statutory standards.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.5.1 Explain the purpose and fundamentals of medium and heavy duty vehicle alignments.

[1/0]
- **camber**
- **caster**
- **KPI**
- **toe-in, neutral toe and toe-out factors**
- **steering geometry dynamics**
- **steering geometry performance analysis**
  - tractor alignment factors
  - tractor-trailer alignment factors
  - coach alignment factors

7.5.2 Identify the functions, types, styles and operation of medium and heavy-duty vehicle alignment equipment.

[1/0]
- **computerized alignment equipment**
- **trammel gauge (bar)**
- **trailer alignment**
- **bazooka**

7.5.3 Describe inspection, testing, diagnostic and demonstrate alignment procedures.

[0/3]
- **inspection and adjust critical steering system components**
- **identify steering system maladjustment**
- **analyze tire wear patterns**
- **test steering system wears limits to statutory requirements**
- **align medium / heavy duty vehicle**

7.5.4 Recommend reconditioning or repairs following manufacturers' procedures on medium and heavy-duty vehicles.

[0/1]
- **describe procedures to replace defective suspension and steering components**
- **outline medium duty vehicle alignment procedures**
- **outline heavy-duty vehicle alignment procedures**
- **outline tractor-trailer combination alignment procedures**
- **outline coach alignment procedures**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - hoists, jacks and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1298.6 Mechanical Steering Gear

Duration: Total 4 hours Theory 2 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5147

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair mechanical steering gear.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.6.1 Explain the history, purpose and fundamentals of mechanical steering gear.

[0.5/0] - **fundamentals enhancement**

7.6.2 Identify the functions, construction, composition, types, styles and application of mechanical steering gear.

[0.5/0]
- **manual steering gear**
- **twin cam and lever**
- **recirculating ball**
- **pneumatic assist**
- **control valve**
- **air cylinder**

7.6.3 Describe the principle(s) of operation of mechanical steering gear.

[1/0]
- **manual steering gear**
- **twin cam and lever**
- **recirculating ball**
- **pneumatic assist**

7.6.4 Perform inspection, testing and diagnostic procedures on mechanical steering gear.

[0/1]
- **visual checks of steering gear box operation and condition for manual and pneumatic assist assemblies.**
- **demonstration of recommended steering angle checks and adjustments**
- **disassemble, inspect, reassemble and adjust manual steering gear**

7.6.5 Recommend reconditioning or repairs following manufactures'' procedures on mechanical steering gear.

[0/1]
- **identify and observe component wear points**
- **adjust steering gear assemblies, linkages, steering stops and column phasing**
- **dismantle, inspect and reassemble manual steering gear boxes.**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - hoists, jacks and stand use
- **communications**
  - information accessing
  - practical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1298.7 Hydraulic Power Assist Steering Gear

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5147

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair hydraulic power assist steering gear.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.7.1 Explain the history, purpose and fundamentals of hydraulic power assist steering gear.

[1/0]
- **hydraulics**
- **hydraulic equations**

7.7.2 Identify the functions, construction, composition, types, styles and application of hydraulic power assist steering gear.

[1/0]
- **hydraulic assist**
  - semi-integral
- **power cylinder**
- **gear assembly**
  - integral hydraulic
  - rack and pinion
- **reservoir**
- **rotary control valve**
- **power cylinder**
- **steering gears**
  - pumps and reservoirs
- **dual steering axles**
  - master gear
  - slave gear
  - linkage arrangement
- **electronically managed steering system**

7.7.3 Describe the principle(s) of operation of hydraulic power assist steering gear.

[1/0]
- **hydraulic assist**
  - power cylinder
  - rack and pinion systems
  - semi-integral gear assembly
  - integral hydraulic
    - reservoir
    - rotary control valve
    - rower cylinder
    - steering arms and linkages
- **pumps and reservoirs**
- **dual steering axles**
  - master gear
  - slave gear
  - linkage arrangement
  - alignment
  - tracking
- electron**ically managed steering systems**

7.7.4 Perform inspection, testing and diagnostic procedures on hydraulic power assist steering gear.

[0/2]
- **perform steering gear assembly adjustments**
- **hydraulic pump pressure tests**
- **hydraulic pump flow rate tests**
- **demonstration of pump internal leakage test**
- **sequential troubleshooting techniques**
- **verify operation of non-adjustable steering gear**

7.7.5 Recommend reconditioning or repairs following manufacturers' on hydraulic power assist steering gear.

[0/1]
- **outline dual steering axle operation**
- **outline procedure required to replace and set up steering gear**
- **outline statutory standards pertaining to steering**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - hoist, jack and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1298.8 Truck, Coach, Bus and Trailer Frames and Bodies

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5144, 5145, 5146

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair truck, coach, bus and trailer frames and bodies.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.8.1 Explain the purpose and fundamentals of frames and bodies.

[1/0]
- **frame dynamics**
- **bridge formula**
- **basic metallurgy**

7.8.2 Identify the functions, construction, composition, types, styles ad application of frames and bodies.

[1/0]
- **ladder**
- **unitized trailer**
- **monocoque / unibody coach**
- **combination (trailer)**
- **telescoping**
- **collision damage categories**

7.8.3 Describe the principle(s) of operation of frames and bodies.

[2/0]
- **frame characteristics**
  - tensional and compressional loading
  - neutral fibre
  - section modulus
  - material strength factors / yield and tensile strength
- **frame materials**
  - aluminum alloys
  - tempered aluminum
  - mild steels
  - tempered steels
- **bridge formula**
- **frame oscillation**
- **resist bend moment (RBM)**
- **RBM calculations**

- **collision damage analyses**
- **attachments**

7.8.4 Perform inspection and testing procedures on frames and bodies.

[0/1]
- **project a frame to floor diagram**
- **identify common frame misalignment factors**
- **diagnose frame failure by types**

7.8.5 Recommend reconditioning or repairs following manufacturers' procedures on frames.

[0/1]
- **outline procedure for removing and replacing cross members**
- **outline procedure for removing and replacing frame rails**
- **outline frame alignment procedure**
- **outline procedure for reconditioning coach unibody chassis**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - spring tension control
  - hoist, jack and stand use
  - heating precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1298.9 Truck and Coach Coupling Devices

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Prerequisites: T.C. Level 2

Cross-Reference to Training Standard:

TCT 5146, 5147

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair of truck and coach coupling systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.9.1 Explain the purpose and fundamentals of coupling devices.

[0.5/0]
- **articulation**
- **traction / tractive vehicle dynamics**

7.9.2 Identify the functions, construction, composition, types, styles and applications of coupling devices.

[0.5/0]
- **fifth wheels**
  - semi-oscillating
  - fully-oscillating
  - non-tilt convertible
  - compensating
  - rigid
  - stationary
  - sliding
    - locking devices
  - no slack
  - cast head
  - pressed head
  - brackets, saddles, pins and bushings
- **kingpins**
  - SAE ratings
- **pintle hooks**
- **eyes**
- **ball hitched**
- **coupler plates**
- **fastener specifications**
- **safety chains**
- **mounting brackets**
- **mounting location**
- trailer landing gear

7.9.3 Describe the principle(s) of operation and inspection of coupling devices.

[1/0]
- **fifth wheels**
  - locking principles
  - secondary locks
  - specifications and ratings
  - mounting height and location
- **pintle hooks**
  - buffer assembly
  - articulation
- **eyes**
- **ball hitches**
- **kingpins**
- **coupler plates**
- **high hitch factors**
- **trailer landing gear**

7.9.4 Perform inspection and testing procedures of coupling devices.

[0/3]
- **check air controls**
  - for leaks
  - operation
- **check coupling devices for**
  - locking ability and security
  - wear tolerances
  - correct engagement
- **disassemble, inspect, adjust and reassemble fifth wheel**
- **verification of lock engagement**
- **indicators of wear**
- **lubrication**
- **tongue weight**
- **welding integrity**
- **fasteners**
  - chains, hooks and cables
- per**formance test overhauled fifth wheels**

7.9.5 Recommend reconditioning or repairs following manufacturers' procedures on coupling devices.

[1/0]
- **removal and cleaning practices**
- **measuring practices**
- **overhaul procedures**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, hearing, breathing and hand protection
  - spring and air pressure reactions
  - fifth wheel locking integrity
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Acronyms:

This listing identifies acronyms found in the following motive power curriculum documents:

Level 1 – Commercial Vehicles and Equipment (Common Core)
Level 2 – Commercial Vehicles and Equipment (Common Core)
Level 3 – Agricultural Equipment Technician
Level 3 – Heavy Duty Equipment Technician
Level 2 – Powered Lift Truck Technician
Level 3 – Powered Lift Truck Technician
Level 2 – Truck and Coach Technician
Level 3 – Truck and Coach Technician

A

ABS	anti-lock braking system
AC	alternating current
A/C	air conditioning
AET	Agricultural Equipment Technician
AFC	air fuel control
AGM	absorbed glass mat
API	American Petroleum Institute
ANSI	American National Standards Institute
ATA	American Trucking Association
ATC	automatic traction control
AVR	amp, volt, ohmmeter
AWG	American Wire Gauge
AWS	American Welding Society

B

BCM	body control module
BSP	British Standard Pipe
BTM	brushless torque motor

C

CAS	collision avoidance system
CB	citizen band
CDI	capacitor discharge ignition
CD-ROM	compact disc read only memory
C-EGR	cooled exhaust gas recirculation
CFC	chlorofluorocarbons
CI	compression ignited
CMVSS	Canadian Motor Vehicle Safety Standard
CNG	compressed natural gas
CPU	central processing unit
CR	common rail
CSA	Canadian Standards Association
CVSA	Commercial Vehicle Safety Alliance
CWS	collision warning systems

D

DC	direct current
DDC	Detroit Diesel Corporation
DIN	Deutsche Institute fur Normung (German Standards Institute)
DMM	digital multimeter
DOS	Disk Operating System
DOT	Department of Transportation
DPF	diesel particulate filter
DTC	diagnostic trouble code

E

ECM	electronic control module
ECU	electronic control unit
EPROM	erasable programmable read only memory
EEPROM	electronically erasable programmable read only memory
EG	ethylene glycol
EGR	exhaust gas recirculation
EUP	electronic unit pump
EHI	electrohydraulic injector
ELC	extended life coolant
EPA	Environmental Protection Act
EST	electronic service tool
EUI	electronic unit injector
EUP	electronic unit pump

F

FACR	fuel amplified common rail
FHSL	Federal Health and Safety Legislation
FMI	fault mode indicators
FMVSS	Federal Motor Vehicle Safety Standards
FOPS	Falling Object Protection System
FRP	fiberglass reinforced plywood

G

GCWR	Gross Combined Weight Rating
GFI	gasoline fuel injection
GPS	global positioning satellite
GVW	Gross Vehicle Weight
GVWR	Gross Vehicle Weight Rating

H

HC	hydrocarbon
HDET	Heavy Duty Equipment Technician
HEUI	hydraulically actuated electronic unit injector
HCFC	hydrochlorofluorocarbons
HFC	hydrofluorocarbons
HPI-TP	high pressure injector-time pressure (Cummins)
HVAC	heating, ventilation and air conditioning

I

ID	inside diameter
ISO	International Standards Organization

J

JIC	Joint Industry Conference
JIS	Japanese Industrial Standard
JIT	just in time

K

KPI	king pin inclination

L

LED	light emitting diode
LPG	liquid petroleum gas
LVD	low voltage disconnect

M

MAP	manifold absolute pressure
MIDs	message identifiers
MIG	metal inert gas
MSDS	material safety data sheet
MUI	mechanical unit injector
MVSA	Motor Vehicle Safety Act (Canadian)

N

N/A	not applicable
NOP	nozzle opening pressure
NPN	negative positive negative semi-conductor
NPT	National Pipe Thread
NV-RAM	non-volatile random access memory

O

OD	outside diameter
ODP	ozone depletion prevention
OEM	original equipment manufacturer
OHSA	Occupational Health and Safety Act
OOS	out of service (criteria)
OPS	operator protection system
ORB	O-ring boss
ORFS	O-ring face seal

P

PC	personal computer
PCV	positive crankcase ventilation
PFI	port fuel injection
PG	propylene glycol
PHSL	Provincial Health and Safety Legislation
PIDs	parameter identifiers
PLC	powerline carrier
PLTT	Powered Lift Truck Technician

PNP	positive negative positive (semi-conductor)
PROM	programmable read only memory
PTO	power take-off
PWM	pulse width modulation

R

RAM	random access memory
RBM	resist bend moment
ROM	read only memory
ROPS	roll over protection system
R.P.	recommended practices TMC
RPM	revolutions per minute

S

SAE	Society of Automotive Engineers
SALT	sealed and lubricated tracks
SCA	supplemental coolant additives
SI	spark ignited
s.i.	Système International d'Unités
SIDs	sub-system identifiers
SMAW	shielded metal arc welding
SRS	supplemental restraint systems
STC	step timing control

T

TBI	throttle body injection
TCT	Truck and Coach Technician
TDS	total dissolved solids
TP	time/pressure injector
TPS	throttle position sensor
TQM	total quality management
TMC	Technical and Maintenance Council

V

VCO	valve closes orifice
VIN	vehicle identification number

W

WHMIS	Workplace Hazardous Materials Information System
WIF	water in fuel sensors

Glossary:

This glossary provides definitions of terms found in the following motive power curriculum documents:

Level 1 – Commercial Vehicles and Equipment (Common Core)
Level 2 – Commercial Vehicles and Equipment (Common Core)
Level 3 – Agricultural Equipment Technician
Level 3 – Heavy Duty Equipment Technician
Level 2 – Powered Lift Truck Technician
Level 3 – Powered Lift Truck Technician
Level 2 – Truck and Coach Technician
Level 3 – Truck and Coach Technician

A

ABS	Anti-lock braking system. Electronically controlled brakes that monitor vehicle wheel speeds and manage application forces to prevent wheel lock-up.
AC	See *alternating current.*
A/C	Air conditioning.
accumulator	A cylinder or device used to store pressure, can contain a diaphragm and pneumatic pressure. Used in hydraulic systems.
Ackermann Angle	Angle between the planes of the steered wheels of a vehicle with zero steering angle; a measure of toe-in or toe-out.
acronym	A word formed by the initial letters of other words.
active codes	An electronically monitored system circuit, condition, or component that is malfunctioning and logs an ECM code, which may be displayed or read using an EST.
actuator	Any output device controlled by a computer. Also used in hydraulics as an output device such as a linear or rotary device (cylinder or motor).
aeration	The mixing of gas with a liquid, usually air with oil, fuel, or coolant.
AFC	Air/fuel control.
AFR	See *air/fuel ratio.*
air/fuel ratio	The mass ratio of an air-to-fuel mixture; also AFR.
air-to-air aftercooler	Heat exchanger that cools the intake air after the turbocharger before going to the intake manifold, by using ambient air.
alcohol	Any of a group of distillate hydrocarbon liquids containing at least one hydroxyl group; sometimes referred to as oxygenates.
alloy	The mixing of a molten base metal with metallic or non-metallic elements to alter the metallurgical characteristics.
alternating current	Electric current that reverses cyclically due to reversal of polarity at the voltage source; AC.
altitude-pressure compensator	Any sensor or device that automatically compensates for changes in altitude.
amboid gear	A bevel gear crown and pinion assembly where the axes are at right angles but the pinion is on a higher plane than the

	crown.
ANSI	The American National Standards Institute.
American Society for Testing Materials (ASTM)	Agency that sets industry standards and regulations, including those for fuel.
ammeter	Instrument for measuring current flow.
ampere (A)	The unit of measurement for the flow of electric current. An ampere is defined as the amount of current that one volt can send through one ohm of resistance.
analog	The use of physical variables, such as voltage or length, to represent values.
anaerobic sealant	Paste-like sealants that cure (harden) without exposure to air.
aneroid	A device used to sense light pressure conditions. The term is used to describe manifold boost sensors that limit fueling until there is sufficient boost air to combust it and usually consists of a diaphragm, spring, and fuel-limiting mechanism.
antifreeze	A liquid solution added to water to blend the engine coolant solution that raises the boiling point and lowers the freezing point. Ethylene glycol (EG), propylene glycol (PG), and extended life coolants (ELC) are currently used.
antifriction bearing	A bearing that uses balls or rollers between a journal and a bearing surface to decrease friction.
API	The American Petroleum Institute.
application software	Programs that direct computer processing operations.
Apprentice program	Any educational program designed to teach a trade through a combination of on-the-job training and classroom study.
Apprentice technician	A beginner who is learning under the direction of one or more experienced certified technicians.
Aqueous Solution	a solution in water, eg. a homogeneous mixture of two or more substances; frequently (but not necessarily) a liquid solution; "he used a solution of peroxide and water"
Aqueous Urea Injection	Is a system that is designed for reducing NOx (Nitrous Oxide) emissions formed in the presence of high combustion temperatures in internal combustion diesel engines. By injecting urea in the exhaust stream, it causes the NOx to break down into nitrogen and oxygen.
arcing	Bearing or gear failure caused by electric arcing.
articulating piston	A two-piece piston with separate crown and skirt assemblies, linked by the piston wrist pin and afforded a degree of independent movement. The wrist pin is usually full floating or bolted directly to the connecting rod, in which case it is known as a *crosshead piston.*
ASTM	American Society for Testing Materials. Standards rating organization that classifies materials generally and all fuels.
ATA	American Trucking Association. Organization with a broad spectrum of representation responsible for setting standards in the U.S. trucking industry.
ATAAC	Air-to-air charge air cooling.
ATDC	After top dead centre.
atom	The smallest part of a chemical element that can take part in a chemical reaction; composed of electrons, protons, and

	neutrons.
atomization	The process of breaking liquid fuel into small droplets by pumping it at a high pressure through a minute flow area.
atomized droplets	The liquid droplets emitted from an injector nozzle.
audit trail	A means of electronically tracking electronically monitored problems in an engine management system. May be discreet, that is, not read by some diagnostic ESTs and programs; also known as *tattletale*.

B

backfire	Ignition/combustion of the fuel in an oxy-acetylene torch in the torch tip causing a popping and squealing noise.
backlash	The clearance or "play" between two parts, such as the teeth of two gears.
battery	A device containing one or more cells that produces electricity through electrochemical action.
battery capacity	The amount of current a battery is capable of delivering.
battery charging	The process of restoring a battery's charge by passing current through it in a reverse direction (positive to negative).
battery plate	Battery components made of lead peroxide in sponge form and porous lead.
battery rating	Standardized measurement of a battery's ability to deliver an acceptable level of energy under specified conditions. Standards established by the battery council international (BCI).
baud	Times per second that a data communications signal changes and permits one bit of data to be transmitted.
baud rate	The speed of a data transmission.
Bernoulli's Principle	The statement that an increase in the speed of a fluid produces a decrease in pressure and a decrease in the speed produces an increase in pressure.
beta ratio	The beta ratio or rating is used for fine filters and is determined under laboratory testing. Although not a true measure of how well a filter will do in an operating system, the beta rating is a good indicator of the filter performance. The beta ratio of an operating filter during steady state flow test is simply the count upstream divided by the count downstream of fine test dust, based on any selected particle size.
binary system	A two-digit arithmetic, numeric system commonly used in computer electronics.
blower	A low-pressure air pump used on diesel engines to increase the amount and pressure of the air coming into the engine. Sometimes referred to as a *supercharger*.
boost pressure sensor	This sensor measures intake manifold air pressure and sends a signal to the ECM.
boost pressure	A measure of positive air pressure provided by a supercharger or turbocharger.
bore	The diameter of an engine cylinder. Sometimes used to refer to the cylinder itself.
boundary lubrication	Thin film lubrication characteristics of an oil.
Boyle's Law	The absolute pressure of a fixed mass of gas varies inversely

	as the volume, provided the temperature remains constant.
brake power	Power developed by an engine measured at the flywheel measured by a dynamometer or *brake*. Factored by *torque* or RPM.
British thermal unit (BTU)	Measurement of the amount of heat required to raise the temperature of one pound of water by 1 degree F, at sea level.
broach	A boring bit used for final, accurate bore sizing.
BTM	Brushless torque motor. Caterpillar rotary proportional solenoid used for PEEC timing and rack position control.
bypass filter	A filter assembly plumbed in parallel with the lubrication circuit, usually capable of high filtering efficiencies.
bypass valve	A diverter valve fitted to full flow filter (series) mounting pads, designed to reroute lubricant around a plugged filter element to prevent a major engine failure.
burst pressure	The pressure which causes rupture. Also, the inside out differential pressure that causes out-ward structural failures.

C

cache	High speed RAM located between the CPU and main memory used to increase processing efficiency.
calorific value	The heating value of a fuel measured in BTU, calories, or joules.
calibration parameters	The specific values required when setting performance to specification.
calipers	Comparative measuring instrument used for measuring outside diameter and inside diameter.
cam ground	Trunk-type pistons that are machined slightly eccentrically. Because of the greater mass of material required at the wrist pin boss, this area will expand proportionally more when heated. Cam ground pistons are designed to assume a true circular shape at operating temperatures.
capacitance	Measure of how much electrical charge can be stored for a given voltage potential; measured in farads.
capacitor	An electrical device that can store an electrical charge or block AC and pass DC. Also known as *condenser*.
carbon (C)	An element found in various forms including diamonds, charcoal, and coal. It is the primary constituent element in hydrocarbon fuels. Atomic #6.
carbon dioxide (CO_2)	One of the products of combustion. Also a dry chemical mixture that is an excellent fire retardant. Compressed into solid form this material is known as dry ice, and remains at a temperature of 109 degrees F.
carbon monoxide (CO)	A deadly colourless, odorless gas that is formed when fuel is not burned completely.
carcinogen	Any substance, such as asbestos, and carbon tetrachloride, that can cause cancer.
cardan joint	A universal joint commonly used as a driveshaft coupler permitting articulation. Two yokes are united by a rigid cross whose races run in a yoke supported needle bearings or races.

case-harden	A process of heating a piece of steel to harden its surface while the inside remains relatively soft.
catalyst	A substance that stimulates, accelerates, or enables a chemical reaction without itself undergoing any change.
catalytic converter	An exhaust system device that enables oxidation and reduction reactions; in lean burn truck diesel engines, only oxidation catalytic converters are used at this moment in time.
cavitation	Describes metal erosion caused by the formation and subsequent collapse of vapor pockets (bubbles) produced by physical pulsing into a liquid such as that of a wet liner against the wall of coolant that surrounds it. Bubble collapse causes high unit pressures and can quickly erode wet liners when the protective properties of the coolant diminish. Also known in hydraulics as a gaseous condition within a liquid stream causing the rapid implosion of a gaseous bubble.
CCW	Counter-clockwise or left hand rotation.
CD	Compact disk. Optically encoded, digital data storage.
CD-ROM	An optically encoded data disk that is read by a laser in the same way an audio CD is read and is designed for read-only data.
centrifugal filter	A filter that uses a centrifuge consisting of a rotating cylinder charged with pressurized fluid and canted jets to drive it; centrifugal filters often have high efficiencies and are often of the *bypass* type.
centrifugal force	The force acting outward on a rotating body.
centrifuge	A device that uses centrifugal propulsion or a centrifugal force principle of operation.
centripetal force	Tendency to move toward a center; such as water draining from a bathtub.
cetane	A colourless liquid ($C_{16}H_{34}$). Used as a basis to test the performance characteristics of diesel fuel.
cetane improver	A diesel fuel additive designed to increase the *cetane number* rating or ignition quality. Cyclohexanol nitrate is a commonly used cetane improver.
cetane number (CN)	The standard rating of a diesel fuel's ignition quality. It is a comparative rating method that measures the ignition quality of a diesel fuel verses that of a mixture of cretonne (good ignition characteristics). A mixture of 45% cretonne and 55% would have a CN of 45. Diesel fuels refined for use in North America are classified by the ASTM as #1D and #2D and must have a minimum CN of 40.
CFM	Cubic Feet per Minute. Used as a measurement for the amount of air entering an engine's intake.
Charles' s Law	See Gay-Lussac's Law.
CI	Compression ignition; an engine in which the fuel/air mixture is ignited by the heat of compression.
clearance	A given space between two parts such as a piston and cylinder.
clearance volume	Volume in an engine cylinder when the piston is at TDC.
clockwise rotation	Rotation is the same as the direction as the movement of the hands of a clock.

coefficient of friction	A rating of a material's ability to generate friction. Describes the "aggressiveness" of materials in contact with each other. Affected by temperature and the presence of lubricants.
Cold crank rating (CCR)	Standard battery rating system that identifies the maximum current drain a fully charged battery can deliver at 0 degrees F or -17 degrees C - measured in cold cranking amps (CCA).
Combustion	The act of burning, *oxidation.*
Combustion chamber	In most current S.I. and C.I. engines, the engine cylinder and the geometry of the head and piston crown form the combustion chamber. In I.D.I. diesel engines, the combustion chamber is a separate cell connected to, but not integral with, the cylinder. Also, the area above the piston with the piston at TDC. Measured in cubic centimeters.
Combustion cycle	The thermodynamic process of a heat engine cycle through induction, compression, oxidation, and exhaust.
Compound	(i) A substance consisting of two or more elements held together by chemical force and not necessarily retaining any of the characteristics of the composite elements; i.e., Water: H_2O: (ii) Auxiliary gearbox that "compounds" the main transmission by increasing the available ratios and ranges.
Compression	The process by which a confined fluid is reduced in volume and increased in density with the application of pressure.
Compression ratio	The ratio of the piston swept volume to the total cylinder volume with the piston at BDC - a volumetric ratio and not a pressure ratio.
Communication Protocol	SAE has specific protocols for mobile equipment communication, such as J1939 J1587/1708
Concentric	Circles having a common centre.
Conductance	The ability of a material to carry an electrical current.
Conductors	Materials that readily permit the flow of electrons from atom to atom; usually metallic elements that have less than 4 electrons in their outer shells.
Conduction	Heat transmission through solid matter, also the transfer of heat from one object to another by being in direct contact.
Connecting rod	The rigid mechanical link between the piston wrist pin and the crankshaft throw.
Constant horsepower	Sometimes used to describe a high *torque rise* engine.
Co-requisite	A unit of learning that can be taken concurrently with another subject, but in order to be successful, both subjects must be completed successfully.
Conventional theory	(Of current flow) asserts that current flows from a positive source to a negative source. Despite the fact that it is fundamentally incorrect, it is nevertheless widely accepted and used.
Convection	A transfer of heat from one object to another through a liquid. Also heat transfer occasioned by the upward flow of hot air and the downward flow of cool air.
Counterbore	Cylindrical enlargement of the cylinder bore at the block deck to seat a liner flange.

Crankshaft	A shaft with offset throws designed to convert the reciprocating movements of the pistons into torque.
Crank throw	The offset part of the crankshaft where the connecting rods fasten.
Creep	Describes the independent movement of two components clamped by fasteners when they have different coefficients of thermal expansion or have different mass, which means their expansion and contraction rates do not concur.
Cross flow	Describes a four-stroke cycle engine breathing configuration where intake and exhaust manifolds are located on opposite sides of the cylinder head so gas flow is across the piston crown.
Crosshead	Part of the valve train in an engine that actuates two valves per cylinder. Permits two valves in the same cylinder to be opened simultaneously by a single rocker arm.
Crosshead piston	An articulating piston with separate crown and skirt assemblies in which the connecting rod is bolted directly to the wrist pin.
Crude oil	The organic fossil fuel pumped from the ground from which diesel fuel, gasoline, and many other petroleum products are refined; raw petroleum.
Current	The flow of free electrons through a conductor.
Curriculum hour	Is described as the breakdown of time for theory and practical in-school delivery. It is timed at 50 minutes per curriculum hour listed in the document.
Cycle time	A reoccurring period in which a series of actions take place in a definite order. Also used in hydraulics as the time it takes for an actuator or function to complete full extend to full retract: thus a cycle time.
Cylinder block	The main frame of any engine to which all the other components are attached.
Cylinder head	A detachable portion of an engine that covers the upper end of the cylinder bores and forms part of the combustion chamber. Also includes the valves in the case of overhead valve engines.
Cylinder sleeve	A liner or sleeve interposed between the piston and the cylinder wall or water jacket to provide an easily replaceable surface for the cylinders.

D

Damper	A unit or device used to reduce or eliminate vibration, oscillation, of a moving part, fluid, etc.
Data	Raw (unprocessed) information.
Database	A data storage location or program.
Data link	The connection point or path for data transmission in networked devices.
Data link connector	Plastic plug-in terminal with two or more electrical connections used to interface with the chassis data bus.
DC	Direct current.
DCA	Diesel coolant additives. A proprietary supplemental coolant additive.

DI	Direct injection. Fuel is injected directly into the engine cylinder. This is the common means of injecting, current C.I. engines and used in some gasoline-fueled engines.
Dial indicator	Tool used to precisely measure linear travel.
Diesel cycle	A four-stroke cycle similar to the Otto cycle (intake, compression, expansion, and exhaust strokes) but where ignition of the fuel charge is occasioned by the heat of compression. A true diesel cycle engine is known as a *constant pressure* engine, meaning that fuel is metered into the cylinder at a rate that will produce constant pressure for a number of crank angle degrees.
Digital signal	An electronic signal that uses on and off pulses.
Diode	A semiconductor device that allows current flow in one direction but resists it in the other, which acts like an electrical check valve.
Displacement	The total volume displaced by the cylinders when moving from BDC to TDC.
Direct current (DC)	Electric current that flows steadily in one direction only.
Droop	An engine governor term denoting a transient speed variation that occurs when engine loading suddenly changes.
Droop curve	A required hydro-mechanical governor characteristic in which fueling drops off in an even curve as engine speed increases from the rated power value to high idle.
Dry air filter	A filter element that requires no oil or other liquid medium to trap dirt particles. Most motive power air filters are of the dry type.
Dry liners	Liners that are fitted either with fractional looseness or fractional interference that dissipate cylinder heat to the cylinder block bore and have no direct contact with the water jacket.

E

Electrohydraulic injector (EHI)	An electronically switched injector that is opened and closed by the engine ECM on the basis of fueling logic and independent of hydraulic pressure. Used in CR and EUP engines.
Electrohydraulic nozzle	Electronically switched nozzle used in dual actuator EUI: as with the EHI, opening is ECM managed independent of hydraulic pressure.
Electromagnetism	Describes any magnetic field created by current flow through a conductor.
Electron	A negatively charged component of an atom.
Electrolyte	A solution capable of conducting electrical current.
Electron theory	The theory that asserts that current flow through a circuit is by electron movement from a negatively charged point to a positively charged one. See *conventional theory*.
Electronic engine management	Computerized engine control.
Electronic control unit (ECU)	Refers to the computer and integral switching apparatus in an electronically controlled system. Some engine OEMs use this term rather than the more commonly used ECM.

Electronically controlled unit injector	Mechanically actuated, electronically controlled unit injector that combines pumping, electronic fuel metering, and injecting elements in a single unit.
Emissions	Any release of harmful materials into the environment. Gases produced from exhaust, crankcase, and fuel tanks and their contribution to smog.
Endplay	Amount of lengthwise movement between two parts due to clearance.
Energy	Any capacity for doing work.
Ethylene glycol	A liquid chemical used in engine coolant. See *antifreeze*.
Exhaust scrubber	An exhaust emission device used to clean particulate matter from engine exhaust. Used predominately in off road equipment for use in underground mining and enclosed buildings.
Expansion ratio	Ratio of cylinder volume at the moment the exhaust port or valves open to clearance volume; usually less than compression ratio.

F

Fatigue	Material failure or deterioration due to repetitive stress loading or usage.
Ferrous material	Metal containing metal or steel.
Fiber optics	The transmission of laser light waves through thin stands of fiber. Used to digitally pulse data more cheaply and at much higher speeds than copper wire.
Fire point	The temperature at which a flammable material or liquid vaporizes at a rate sufficient to burn continuously.
Flammable	Any substance that can be combusted.
Flashback	A highly dangerous condition that can occur in operating oxy-acetylene equipment in which the flame may travel behind the mixing chamber in the torch and explode the acetylene tank using the system oxygen. Most current oxy-acetylene torches are equipped with flashback arresters.
Fluid power	The term used to describe both *hydraulics* and *pneumatics*.
Flywheel	A large heavy wheel that forms the base for the starter ring gear and in which energy is absorbed and stored by means of momentum. Also provides a mounting surface for the torque converter or clutch assembly.
Force	The action of one body attempting to change the state of motion of another. The application of force does not necessarily result in any work accomplished.
Friction	The resistance an object or fluid encounters in moving over or though another.
Four-stroke cycle engine	An engine design where a power pulse occurs every other revolution of the crankshaft. These strokes are (1) intake stroke (2) compression (3) power or expansion stroke; and (4) exhaust stroke.
Full-floating	Used to describe components that permit more than the usual amount of movement-for instance a *full-floating piston pin* is retained in the pin boss, but permits independent movement of both the piston and the rod eye.

Full floating axle	A drive axle design where the axle shafts provide wheel torque only and bear no part of the vehicle load.

G

Gay-Lussac's Law	The law that at constant pressure the volume of a fixed mass or quantity of gas varies directly with the absolute temperature; a close approximation. Also known as Charles's Law.
General Learning Outcomes	Learning outcomes represent culminating demonstrations of learning and achievement. Outcomes are not simply a listing of discrete skills, nor broad statements of knowledge and comprehension. Outcomes describe performances that demonstrate that significant learning has been achieved and applied.
General Practices	This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the learning content.
Governor	A component that manages engine fueling on the basis of fuel demand (accelerator) and engine RPM; may be hydro-mechanical or electronic.
Grade markings	Lines placed on the heads of some bolts to indicate tensile strength.
Gross Horsepower	The brake horsepower of an engine with optimum settings and without allowing for power absorbed by the engine-driven accessories.
Gross Torque	The maximum torque produced when measured at the engine's crankshaft. Does not allow for torque consumed by the engine-driven accessories.

H

Hall Effect	A method of accurately sensing rotational or linear speed and digitally signaling it. A rotating metallic shutter alternately blocks and opens a magnetic field from a semiconductor sensor.
Hazardous Waste	Any chemical or material that has one or more characteristics that make it hazardous to health, life, and/or the environment.
Heat	A form of energy associated with the motion of atoms or molecules and capable of being transmitted by conduction, convection, and radiation.
Helix	A spiral groove or scroll. The helical cut recesses in some injection pumping plungers that are used to meter fuel delivery. Plural: *helices*.
Hg manometer	A mercury (Hg) filled manometer.
High Idle Speed	The highest no load speed of an engine.
Hooke's Law	The law that the stress of a solid is directly proportional to the strain applied to it.
Horsepower (hp)	Measurement of an engine's ability to perform work. One horsepower is defined as the ability to move 33,000 pounds one foot in one minute.
H_2O Manometer	A water-filled manometer.

Hunting	Rhythmic fluctuation of engine RPM usually caused by unbalanced cylinder fueling.
Hydraulics	The science and practice of confining and pressurizing liquids in circuits to provide motive power.
Hydrodynamic suspension	The principle used to float a rotating shaft on a bed of constantly changing, pressurized lubricant.
Hydraulic electronic unit injector (HEUI)	Unit injector featuring a hydraulically-actuated injection pumping, with an electronically controlled injector. Combines fuel metering and injecting elements into a single unit.
Hydrocarbon	Describes substances primarily composed of elemental carbon and hydrogen. Fossil fuels and alcohols are both hydrocarbon fuels.
hydromechanical engine management	All engines managed without computers.
Hydrometer	An instrument designed to measure the specific gravity of liquids, usually battery electrolyte and coolant mixtures. Not recommended for measuring either in truck engine applications where a refractometer is the appropriate instrument due to greater accuracy.
Hypoid gear	A bevel gear crown and pinion assembly where the axes are at right angles but the pinion is on a lower plane than the crown.
Hysteresis	(i) In hydromechanical governor terminology, a response lag. (ii) Molecular friction caused by the lag between the formation of magnetic flux behind the magnetomotive force that creates it.
Impedance	The combination of resistance and reactance in an AC circuit.
Indirect injection (IDI)	Describes any of a number of methods of injecting fuel to an engine outside of the cylinder. This may be to an intake tract in the intake manifold or to a cell adjacent to the cylinder such as a pre-combustion chamber.
Indicated horsepower	Gross power produced in the engine cylinders often arrived at by calculation and always greater than *brake power* because it does not factor in pumping and friction losses.
Industry Committee	A committee of industry members who are representative of the province and help to guide the MTCU about apprenticeship issues.
Inertia	In physics, it describes the tendency of a body at rest or in motion to continue that state unless it is changed by an external force.
Inline block	An engine that has all of its cylinders aligned in a straight row.
Insulator	Materials that either prevent or inhibit the flow of electrons: usually nonmetallic substances that contain more than four electrons in their outer shell.
Integral	Whole or combined with another component to act as a single unit.
Isochronous governor	A zero droop governor or one that accommodates no change in RPM on the engine it manages as engine load varies. In electronically managed truck engines, the term is sometimes used to describe engine operation in PTO mode.

J

Jounce	Literally "bump"-used to describe the most compressed condition of a suspension spring.
Journal	The part of an axle or shaft that actually contacts the bearing.
Jumper pipe	A term used to describe the pipes that connect the charge and return galleries with DDC MUIs or with each other in multi-cylinder heads.

K

Kinetic energy	Any energy associated with motion.
Kingpin inclination	Inclination angle of the steering axis to a vertical plane.
Kirchhoff's 1st Law	States that the current flowing into a point or component in an electrical circuit must equal the current flowing out of it.
Kirchhoff's 2nd Law	States that the voltage will drop in exact proportion to the resistance in a circuit component and that the sum of the voltage drops must equal the voltage applied to the circuit; also known as Kirchhoff's Law of voltage drop.

L

Lambda sensor	An exhaust gas sensor used on electronically managed, SI gasoline-fueled engines to signal the ECM the oxygen content in the exhaust gas.
Laminar flow	A condition where the fluid particles move in continuous parallel paths; streamline flow.
Lead acid battery	Standard vehicle battery consisting of lead acid cells in series. Twelve volt batteries have become standard and they can be used in multiples in parallel or series for heavy duty applications.
L-head engine	An in-line engine configuration where the intake and exhaust valve ports are located adjacent to the cylinder in the block. Seldom used in current engines.
Learning outcome	Learning outcomes are discrete statements that describe the elements leading to attainment of the general learning outcome.
Learning content	The learning activities required for the learner to achieve the Learning Outcomes. A comprehensive list of activities to guide the trainer.
Liner protrusion	The amount the liner protrudes above the deck of the block, thus allowing retention when the head is properly torqued.
Logic	(i) The science of reasoning. (ii) Arithmetic and data comparison protocols of a microprocessor.

M

Magnetism	The phenomenon that includes the physical attraction for iron observed in lodestone and associated with electric current flow. It is characterized by fields of force, which can exert a mechanical and electrical influence on anything within the boundaries of that field.
Manometer	A tubular, U-shaped column mounted on a calibration scale.

	The tube is water or mercury-filled to balance at 0 on the scale and the instrument is used to measure light pressure or vacuum conditions in fluid circuits.
Mechanical efficiency	A measure of how effectively *indicated power* is converted into *brake power;* factors in pumping and friction losses.
Micrometer	A precision instrument for measuring either internal, external, or depth dimensions to within thousands or ten thousands of an inch or millimeter.
Micron	One millionth of a meter or .000039 inch. The term used to rate the size of filters for liquids, such as engine oil or hydraulic fluids.
Muffler	An *engine silencer* that uses sound absorption and resonation principles to alter the frequency of engine noise.
Mechanical Unit Injector (MUI)	Cam-actuated, governor-controlled unit injectors used by DDC and Caterpillar.
Multimeter	A test instrument capable of reading volts, amps, and ohms.
Multi-orifii nozzle	A typical hydraulic injector nozzle whose function it is to switch and atomize the fuel injected to an engine cylinder. Consists of a nozzle body machined with the orifii, a nozzle valve, and a spring. Used in most DI diesel engines using port helix injection pumps, MUIs, EUIs, and HEUIs.
Multiplexing	A method of using one communications path to carry two or more signals simultaneously.

N

Nitrogen dioxide	One of the oxides of nitrogen produced in vehicle engines and a significant contributor in the formation of photochemical smog.
Non-ferrous metal	Metals and alloys that contain little or no iron.
Non-volatile RAM	NVRAM-read-write RAM device capable of data retention in cells in a vehicle module after the ignition circuit is opened; also known as KAM
Normal rated power	The highest power specified for continuous operation of an engine.

O

O. Reg.631/94 section 3	Is an Ontario regulation for regulations as they apply to overhead cranes.
OEM	Original equipment manufacturer.
Ohm	A unit for quantifying electrical resistance in a circuit.
Ohm's Law	The formula used to calculate electrical circuit performance. It asserts that it requires 1 v of potential to pump 1 A of current through a circuit resistance of 1 ohm.
Ohmmeter	An instrument for measuring resistance in an electric component or circuit.
Opacity meter	A light extinction means of testing exhaust gas particulate and liquid emission that rates density of exhaust smoke based on the percentage of emitted light that does not reach the sensor, so the higher the percentage reading, the more dense the exhaust smoke.
Orifice	A hole or aperture.

Orifii	Plural of orifice.
Oscilloscope	An instrument designed to graphically display electrical waveforms on a CRT or other display medium.
Otto cycle	The four stroke, spark ignited cycle, patented by Nicolas Otto in 1876 and consisting of induction, compression, power and exhaust strokes.
Overhead camshaft	An engine which locates the valve actuating camshaft(s) in the cylinder head to either directly or indirectly actuate the valves and in some diesel applications, the unit injectors.
Oxy-acetylene	A commonly used cutting, heating, and welding process that uses pure compressed oxygen in conjunction with acetylene fuel.
Oxidation	The act of oxidizing a material; can mean combusting or burning a substance.
Oxides of nitrogen (NOx)	An undesirable compound of nitrogen and oxygen in exhaust gases. Usually produced when combustion chamber temperatures are excessively high.

P

Packet	Bit architecture of a multiplex message
Parallel port valve configuration	Engine cylinder valve arrangement that locates multiple valves parallel to crank centreline permitting equal gas flow through each (assuming identical lift).
Particulate trap	A canister in series with the exhaust piping containing a filtering medium to entrap diesel HC exhaust particulates and in some instances oxidize them.
Pascal's Law	A principle of fluids that states that when pressure is applied to a confined fluid, it is transferred undiminished throughout the fluid.
PC networks	Any of a variety of small personal computers designed for full function in isolation from other units but which may be used to network with other systems.
Piezoelectric Principle	Certain crystals become electrically charged when exposed to pressure, the voltage produced increasing proportionally with pressure rise. Quartz and Rochelle salt crystals have these properties. Combustion pressure sensors may both use the *Piezoelectric Principle*.
Pintle nozzle	A type of hydraulic injector nozzle used in some IDI automobile, small bore diesel engines until recently.
Plenum chamber	A chamber or cavity in which a fluid is held at a pressure above atmospheric or above system mean pressure.
Pneumatics	Branch of fluid power physics dealing with pressure and gas dynamics.
Poppet nozzle	Forward opening injector nozzle valve used on older Caterpillar IDI systems.
Port-helix metering	Consists of a pumping plunger and barrel assembly designed to regulate fuel delivery.
Potentiometer	A three-terminal variable resistor or voltage divider used to vary the voltage potential of a circuit. Commonly used as a throttle position sensor.
Power	The rate of accomplishing work; it is necessarily factored by

	time.
Practical	The hands-on element of learning in the curriculum document. Apprentice activities develop skills to achieve completion of psychomotor learning outcomes.
Preloading	Process of adjusting a bearing so that it has a mild pressure placed upon it, beyond zero endplay.
Prerequisite	Learning that must be achieved prior to taking a given subject.
Pressure	Force exerted per unit of area.
Pulse width modulation	The shaping of pulses and waveforms for purposes of digital signaling. Acronym PWM is often used.
Pyrometer	A thermocouple type, high temperature sensing device used to signal exhaust temperature. Consists of two dissimilar wires (pure iron and constantan) joined at the hot end with a millivoltmeter at the read end. Increase in temperature will cause a small current to flow, which is read at the voltmeter as a temperature value.

Q

Quenching	Process of dipping a heated object into water, oil, or other substance to quickly reduce its temperature.
Quiescent Combustion	Non-turbulent flame propagation characteristic of slow running diesel engines that are direct injected.

R

Radial	A line at right angles to a shaft, cylinder, etc., Centerline.
RAM	Random access memory. Electronically retained "main memory."
Rated power	The highest power specified for continuous operation.
Rated speed	The RPM at which an engine produces peak power.
Reluctor	Term describing a number of devices that use magnetism and motion to produce an AC voltage-a pick-up coil.
Rebound	Reactive response of a spring, the opposite of jounce.
Reportable Subject	(i) A clustering or grouping of related or like learning outcomes. (ii) A standalone learning unit with a distinct start and end. (iii) A course or module.
Reserve Capacity	The amount of time a battery can produce an acceptable current when not charged by the alternator.
Rheostat	A two terminal, variable resistor.

S

SAE	Society of Automotive Engineers.
SAE horsepower	A structured formula used to calculate brake horsepower data that can be used for comparison purposes.
Scoring	Scratch/gouge damage to a surface finish.
Semiconductor	A substance, such as silicon, that acts as a conductor or insulator, depending on its operating condition and application.
Semi-floating axle	A drive axle design in which the axle shaft imparts drive to the wheel and supports the vehicle weight.

Sensor	A term that covers a wide range of command and monitoring input (ECM) signal devices.
Shunt winding	A wire coil that forms an alternate path through which electrical current can flow.
s.i.	système international d'unités. A measure in metric units.
Silicon	A non metallic element found naturally in silica, silicone dioxide in the form of quartz.
Silicon-controlled rectifier	Function similarly to a bipolar transistor with a fourth semiconductor layer; used to switch DC.
Smart term	Used to describe components or subsystems with processing capability or direct-controlled by an ECM. Examples: smart cruise/ smart injector.
Spark ignition (SI)	Any gasoline-fueled, spark-ignited engine usually using an Otto cycle principle.
Specific gravity	A relative weight of a given volume of a specific material as compared to an equal volume of water.
Spiral gear	A winding helical protrusion or thread machined to a shaft, as in a worm gear.
Static electricity	Accumulated electrical charge not flowing in a circuit.
Stoichiometric Ratio	The exact ratio of reactants participating in a reaction required to complete the reaction. Most often used in the context of explaining the mass of air required to completely combust a fuel.
Supercharger	Technically any device capable of providing manifold boost, but in practice used to refer to gear-driven blowers such as the Rootes blower.
Sulfur	An element present in most crude petroleums, but refined out of most current highway fuels. During combustion, it is oxidized to sulfur dioxide, and classified as a noxious emission.
Sulfur dioxide	The compound that is formed when sulfur is oxidized that is the primary contributor to sulfurous type smog. Vehicles contribute little to sulfurous smog problems due to the use of low sulfur fuels.
Supplemental Restraint System (SRS)	An emergency inflatable air bag system designed to enhance crash safety.
Swept Volume	The volume displaced in a cylinder as a piston moves from BDC to TDC.
Synthetic Oils	Petroleum based oils that have been chemically compounded by polymerization and other processes.
T	
TDC	Top dead centre of an engine.
Tensile strength	Widely used term denoting the required unit stress to cause material separation. In ferrous alloys, tensile strength usually exceeds yield strength by about 10%. Measured in force per unit area, psi.
Theory	The theoretical hours listed in the curriculum document that represent learning in the cognitive domain, the thinking portion of the training.
Thermal Efficiency	Ratio of brake power to that of the calorific value (heat energy

	potential) of a material failure caused by engine performance.
Thermistor	A commonly used temperature sensor that is supplied with a reference voltage and by using a temperature sensitive variable resistor, signals back to the ECM portion of it.
Thrust faces	A term used to describe loading of surface area generally but most often of pistons. When the piston is subject to cylinder gas pressure there is a tendency for it to cock (pivot off a vertical centerline) and load the contact faces off its axis on the pin.
Torque	Twisting effort or force. Torque does not necessarily result in accomplishing work.
Torque rise	The increase in torque potential designed to occur in a diesel engine as it is lugged down from the rated power RPM to the peak torque RPM, during which the power curve remains relatively flat. High torque rise engines are sometimes described as constant horsepower engines.
Training Standards	Training standards are created by the MTCU with the Industry Committee and are intended to be used by the apprentice, instructors, and companies as a "blueprint" for on-the-job training, or as a prerequisite for government certification.
Transducer	A device that coverts energy from one power form to another for instance, a physical pressure value to an electrical pressure value.
Trunk piston	A single piece piston usually constructed of aluminum alloy.
Turbocharger	A turbine device that utilizes exhaust pressure to increase the air pressure going into the cylinders. Used particularly in reference to movement of air in the cylinder and combustion chamber.
Turbulence	A violent irregular movement or agitation of a fluid or gas. Violent swirling motion. Fuel injection provided some turbulence. Additional turbulence is provided by the design features of the combustion space.
Turbulent Flow	A condition where the fluid particles move in random paths rather than in continuous parallel paths.
Two-stroke cycle	An engine that requires one complete revolution of the crankshaft to fire each piston once. An engine requiring only one complete revolution of the crankshaft to complete the cycle of events.

U

Unit injector	A diesel fuel injector which receives fuel at charging pressure and performs the functions of metering, creating injection pressure values and atomizing fuel-usually directly to the engine cylinder. Mechanically or electronically controlled, mechanically or hydraulically actuated.
Universal joint	A flexible joint that permits changes in driving angles between a driving and driven shaft.
Urea	synthesized ammonia and carbon dioxide used to break down NOx compound bonds into elemental oxygen and nitrogen

V

Valve timing	Crank angle locations in the cycle when the valves are open and closed.
Valve train	The sum of the components responsible for actuating a valve, extending from the cam profile to the valve itself.
V-engine	Engine configuration in which the cylinders are arranged so that their axes form a V. Described by the angle, most commonly, 45, 60, and 90 degrees.
Volatility	The ability of a liquid to evaporate. Gasoline has greater volatility than diesel fuel.
Volute	A snail-shaped diminishing sectional area such as used in turbocharger geometry.
Viscosity	Defines fluid shear but often used to describe the fluidity of a liquid.
Viscosity Index	A measure of a liquid's resistance to shear at a specific temperature-diminishes as temperature drops and vice versa.
Viscous damper	An engine vibration damper consisting of disc shaped housing containing a fluid medium (silicon gel) and a solid inertia ring; uses fluid friction to dampen torsional oscillation.
Voltmeter	Instrument for testing charge differential or voltage in a circuit.
Volumetric efficiency	Engine breathing efficiency. Extent to which end gases are purged from an engine cylinder, usually expressed as a percentage of new charge to cylinder volume. A ratio of mass not volume. Seldom 100% in naturally aspirated engines, can be greater than 100% in boosted engines.

W

Wastegate	A valve that vents excess exhaust gas to limit the amount of boost delivered by a turbocharger.
Watt's Law	Formula for computing unknown power, voltage, or current in a circuit by using two known factors to find the unknown value.
Wet liners	Cylinder block liners that have direct contact with the water jacket and therefore must support cylinder combustion pressures and seal the coolant to which they are exposed.
Wheatstone bridge	A galvanometer that bridges an electrical circuit to give a resistance reading.

Y

Yield strength	The stress loading required to permanently deform a material-automotive construction materials, especially steels, are classified by yield strength rating.

Z

Zenor diode	Specialty diode designed to conduct with a reverse bias current after a specific voltage value is reached.